# A FRAMEWORK TO SUPPORT A SYSTEMATIC APPROACH

# TO UNIT COST DEVELOPMENT

A Thesis

by

SUSHANTH RAMESH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2009

Major Subject: Civil Engineering

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Approved by:

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| Chair of Committee, | Stuart D. Anderson |
| Committee Members, | Ivan Damnjanovic |
| | Thomas E. Wehrly |
| Head of Department, | John Niedzwecki |

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# ABSTRACT

A Framework to Support a Systematic Approach to

Unit Cost Development. (December 2009)

Sushanth Ramesh, B.E.; B.Tech., Anna University

Chair of Advisory Committee: Dr. Stuart D. Anderson

Availability of historical unit cost data is an important factor in developing accurate project cost estimates. State highway agencies (SHAs) collect data on historical bids and/or production rates, crew sizes and mixes, material costs, and equipment costs, including contractor overhead and profit. The objective of this research is to create a framework to define a standardized and a systematic approach for developing unit costs for construction project estimating. A literature review was conducted that provided an overview of estimating techniques used in project estimating, estimation guidelines maintained by SHAs, and information systems used in the estimation process. After gaining a broad overview of the industry's approach to unit cost development, a survey was then conducted. The purpose of the survey was to identify the state of practice in SHAs for unit cost development. The survey helped to identify SHAs doing considerable work in unit cost development and interviews were conducted with these agencies to know their unit cost development process in detail. The results from survey and the interviews were then used in defining the framework. The framework provides a standardized way to use historical data for preparing construction project estimates.

## DEDICATION

This thesis is dedicated to my parents, Mrs. Meenakshi Ramesh and Mr. Rajagopalan Ramesh.

## ACKNOWLEDGEMENTS

I would like to thank Dr. Stuart Anderson for giving me an opportunity to work on this research project and for guiding me and supporting me throughout this project. I would also like to thank Dr. Ivan Damnjanovic and Dr. Thomas Wehrly for being on my advisory committee and for their guidance and support. I would also like to express my appreciation to the Texas Department of Transportation for sponsoring the TxDOT 0-6023 research project. I would also like to thank Ali Nejat for helping me throughout the research. I would like to thank Hariharan Subramanian, Hari Prasad Nandakumar, Srinath Sudharshan Narasimhan, Rahul Ravikumar, and Amrish Deep Ravidas who have been family to me over the past few years. Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience.

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# CHAPTER I

# INTRODUCTION

Project cost estimates play a crucial role in development of construction projects. The cost estimates are continuously updated in each phase of the project development process as new information becomes available. The Engineer's Estimate is the final estimate prepared by the state agencies in the Plan, Specifications, and Estimate (PS&E) phase. This estimate is particularly important because the state agency uses it to compare the estimated cost with contractor bid prices and obligate funds for construction.

## BACKGROUND

This research was conducted for Texas Department of Transportation (TxDOT) Research Project No. 0-6023: *Synthesis on Construction Unit Cost Development*. The project was a synthesis on unit cost development procedures followed by various SHAs for estimating construction and maintenance projects. The objective of this research was to explore the current practices in determining the unit costs based on historical bids and/or historical production rates, crew sizes, labor wage rates, equipment costs, and material costs. The processes and procedures SHAs utilize for developing unit costs for project estimation were then compared with TxDOT practices and procedures. The comparison formed the basis from which recommendations are provided to TxDOT.

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This thesis follows the style of *Journal of Construction Engineering and Management.*

The research focused on understanding the historical bid information used by SHAs for developing the unit costs for both construction and maintenance project. In order to obtain more information about the unit costs, four major categories of unit cost information were identified as part of research: 1) acquiring unit cost, 2) storing unit cost, 3) accessing unit cost, and 4) applying unit cost. A general section was also included which addressed the estimating procedure followed by agencies at different project development phases. The research involved a work plan that revolved around the above defined categories and consisted of four major tasks.

The first task was to review the literature to generate a broad understanding of issues and actions SHAs and other contracting agencies were using to develop unit costs for estimating construction and maintenance projects. The second task was to conduct a survey to identify the state of practice within SHAs for developing unit costs for project estimation. The intent was to quickly identify agencies having best practices in this area as well as documented procedures that implement their best practices. The third task was to obtain a better understanding of how the best practices and procedures of key states were performed thorough hands on discussion with individuals from key states. This task also consisted of understanding the state of practice followed by TxDOT. The final task consisted of developing results and recommendations based on the comparison of practices followed by TxDOT and other state agencies.

The research for this thesis focused on establishing best practices and procedures for construction project estimation alone. Therefore the thesis is a compilation of research accomplished for all above four tasks under the categories of unit cost

information identified. The thesis consists of framework developed for unit cost development for construction projects using the best practices identified from task two and three.

## PROBLEM STATEMENT

Cost estimating occurs repeatedly throughout the phases involved in the project development process. The use of the Historical Bid-Based or Cost-Based estimating technique depends on the project phase and the level of project scope information available. Historical cost data that supports the preparation of estimation also vary based on the estimating techniques. Historical bid prices are often used when preparing cost estimates. At the PS&E phase, bid pricing is the most common approach, although some State Highway Agencies (SHAs) use production rates, crew sizes, labor wage rates, material costs, and equipment costs to build a unit price for their Engineers' Estimates. Historical bid prices are more frequently used for estimates prepared in the scoping and design phases. In the planning phase, estimators often use historical unit prices to develop average lane mile costs for planning estimates.

The effectiveness of both techniques is a function of the historical cost data available to support the two estimating techniques. This research tries to address the problem of the lack of systematic methodology to apply unit costs for construction projects. If such a systematic approach is not defined, estimators will spend considerable time searching databases for unit costs. Furthermore, having a standard

approach that includes keeping the historical unit costs current will aid the estimator in making more consistent and accurate estimates.

## RESEARCH QUESTIONS

The research problem raises numerous questions that will be addressed during the research. The key questions are:

1. What is the standardized and systematic way to develop unit costs from historical data for construction cost estimation?
2. What techniques and tools can be applied to historical data to prepare an estimate at different project phases?
3. How can historical unit cost data be made available to estimators effectively?
4. What new and innovative strategies can be applied to develop unit costs?

## RESEARCH OBJECTIVES

The research questions identified above helped develop several objectives for the research. The first objective is to explore the current practices followed by different SHAs in determining the unit costs from historical data. The second objective is to identify the best practices in determining the unit costs based on historical bids and/or historical production rates, crew sizes, labor wage rates, equipment costs, and material costs. This will also include identifying new and innovative techniques adopted by SHAs

for developing unit costs. The third objective is to develop a framework that will define a standardized and systematic approach to construction unit cost development by encompassing the best practices from the industry.

## DELIMITATIONS OF THE STUDY

The problem statement was studied after identifying the boundaries for this research. The intent of this research was not to collect data for a statistical analysis, but to develop a unit cost development framework based on literature and qualitative information provided by SHAs. Therefore this project follows a qualitative approach for its research methodology. The information collected from the SHAs does not represent all fifty states, thus it is not known if all states are void in the area described throughout this thesis. Moreover, the SHAs provided only a detailed overview of their unit cost development practice applied to all their projects. The research also does not study the accuracy of the project estimates, but the approach used by estimators to develop project estimates.

## ORGANIZATION OF THE STUDY

Chapter I outlines the background information of this project along with the problem statement, research questions, and research objectives. Chapter II focuses on cost estimating practices, historical databases for unit costs, and systems used in

developing project estimates found during an in-depth literature review. Chapter III explains the approach followed for conducting this research project. Chapters IV and V discusses the unit cost development practice followed by different SHAs. Chapter VI explains the unit cost development framework. Chapter VII concludes with the summary, conclusions and recommendations for future research.

# CHAPTER II

# LITERATURE REVIEW

Project cost estimation plays an integral part in the development of any construction project. The estimation process begins as early as the planning phase with preparation of planning-level, or conceptual, estimates. As more details of the project become available, the estimates become more detailed. Conceptual estimates become design-level estimates and progress further to become the Engineer's Estimate. This estimate is used as a baseline estimate against which the bids submitted by the contractors are compared and construction is awarded. Every estimate typically consists of the different types of work in the project, its associated quantity, and the cost. The purpose of the research is to identify the process involved in developing the unit cost for each item of work.

The review of literature showed that there is no single approach to developing construction unit costs. Typically, SHAs have developed their own process for preparing their project estimates, tailor made to suit their requirements. As a result, highway construction projects employ a number of estimating procedures.

A number of studies have investigated techniques used for cost estimation. The most common estimating technique reported is the historical bid-based estimation. According to AASHTO (2007) historical bid-based estimation is a method of developing estimates using data from the unit cost database. The unit cost database is a repository of the costs associated with all standard items of work taken from the previously awarded

contracts or bids. This database stores information in a suitable format to aid the estimator in preparing cost estimates for highway projects. The unit price from this database is adjusted to reflect the specific project characteristics and project location (geographic) conditions.

Cost-Based Estimating is an estimation technique also used by SHAs but with less frequency. This method is used in developing project estimates based on production rates and the cost associated with labor, materials, and construction equipment. By estimating the cost of each component required to complete the work together with a contractor's profit and overhead, SHAs develops an estimated unit price for the work. This method also takes into account the unique character of the projects, geographical location, market factors, and volatility of material prices. Cost-based estimation is mainly used in preparing the Engineer's Estimate, as this method can provide a more accurate and defendable cost to support the decision for contract award/rejection.

In addition to bid-based estimation and cost-based estimation, SHAs use parametric estimation early in project development. Parametric estimation, as defined in Washington State Department of Transportation's (WSDOT) Cost Estimation Manual, is a method to estimate the cost of a project or a part of a project based on one or more project parameters. Historical bid data are used to define the cost of a typical transportation facility segment, such as cost per lane mile, cost per interchange, or cost per square foot of a bridge structure. SHAs can also use historical percentages to estimate project segments based on major project parameters. These methods are often used in early estimating, such as planning and scoping.

## ESTIMATING GUIDELINES

Agencies maintaining guidelines on cost estimating have outlined the factors that estimators need to consider when determining the unit prices for various line items. The common factors identified in the estimation manuals of Utah Department of Transportation (UDOT 2008a), Virginia Department of Transportation (VDOT 2008a) and Pennsylvania Department of Transportation (Penn DOT 2007) are:

- Project location,
- Project size,
- Quantity of materials,
- Time of year,
- Current market conditions,
- Constructability,
- Price-volatile materials,
- Sequence of construction,
- Contractor's familiarity of process,
- Risks to contractors, and
- Inflation.

Even though availability of guidelines and manuals on cost estimating ensure better estimates, in order to increase the accuracy of the estimates, the estimator must have a strong knowledge of costs as well as implicit design knowledge (De la Garza and Oralkan 1991). The design knowledge insures that all components of work are included

in the estimates. Without knowledge of the construction methodologies, the estimator may not realize that each component has its own associated cost that may have a significant impact on the final estimate.

Estimating guidelines available for WSDOT, UDOT, and Penn DOT outline the steps involved in preparing estimates in each of the project development phases. The four main project development phases identified in the NCHRP Report 574 are:

- Planning – concept definition to support a 20-year long range plan;
- Programming – basic scope definition to place a project into a priority program (10 years or less from the project letting date);
- Preliminary Design – development of plans and specifications to support a project in the State Transportation Improvement Program (4 years or less from the letting date); and
- Final Design – final plans and specifications to support an Engineer's Estimate for letting a project for construction.

**Planning**

According to the Cost Estimating Manual (WSDOT), the planning level estimate is used during the Project Definition and Project Initiation and Alignment phase to determine funds for long range planning and to prioritize the need for the highway system plan. Planning level estimates are prepared using either parametric estimating where the input from a per-mile cost for the roadway is combined with a per-square foot structure cost or by analogous project estimating (Cost Estimating Guidelines Penn DOT, 2007).

**Programming**

A scoping level estimate is used during the post planning phase to set the baseline cost for the project and to program the project. This phase uses the bid-based estimation and parametric estimation methods of estimating. Here estimators determine approximate quantities for items such as asphalt, concrete pavements, structures, and roadway excavations. While most agencies update their planning level spreadsheets with more details for preparing the scoping level estimates, some agencies use sophisticated systems for preparing the same estimate.

**Preliminary Design**

Design level estimates help in development of plans and specifications to support a project in the State Transportation Improvement Program (STIP). The project requirements typically become clearer at this stage. This solidifies many items in the scope such as Right of Way (ROW), permit conditions, quantities of major items, and outside stakeholders. Historical bid-based estimating and historical percentage estimation techniques are used in developing design level estimates. Some agencies also use cost-based estimating to estimate major items of work, that is, items having high cost impacts (80-20 Rule). At this stage many agencies use sophisticated computer software to prepare the preliminary design estimates.

**Final Design**

At this phase the final Engineer's Estimate is prepared for advertising the project, obligating construction funds, and evaluating contractors' bids. All the items of work required for the project, their quantities, and unit prices are available at this stage.

Historical bid-based estimating and cost-based estimating are the two methods used in preparing the Engineer's Estimate. Commercial software like Estimator and CES of the Trns*port system are commonly used in preparing estimates at this level. Some agencies use their own in-house developed computer system, like the Project Development Business System (PDBS) of UDOT, and Estimate and Bids Analysis System (EBASE) of WSDOT to prepare the final estimates.

## INFORMATION SYSTEMS

The development of estimating software and its proliferation into the transportation industry has enabled estimators to make faster and more accurate estimates. Computer software allows the estimators to manage large volumes of project information. Estimator, a module of the Trns*port system, is the commonly used estimating software with 22 state agencies use the Estimator module (Schexnayder et al. 2003). CES is another module of Trns*port used by state agencies. Some agencies use Bid Tabs Pro® developed by Oman Systems to aid in estimate preparation.

Historical bid prices are necessary to prepare estimates from the planning phase of project development through the final design phase. SHAs have extensive databases of their historical bid prices which are used by their estimation software. The historical database provides the necessary bid data to prepare the base estimates as shown in Figure 1. The highlighted portion in Figure 1 shows the use of historical database in the development of planning level base estimate (NCHRP 2007). In addition, the historical

database will also be used in preparing the scoping phase, design phase, and PS&E phase base estimates. The focus of this research will be to understand the practices and procedures followed by SHAs in: (1) extracting bid details from submitted bids, (2) storing this information in historical database, and (3) making this information available to estimators for preparing the base estimates.

The database structure can be as simple or complex as the estimating needs dictate (Practical Guide to Estimating, AASHTO's Technical Committee on Estimating, 2007). A historic bid price database can be created using the Bid Analysis Management System (BAMS), which is the Decision Support System (DSS) of Trns*port system. This historical database holds the construction contract information. When establishing a database, all aspects of a project that may become necessary during estimating should be saved. The following list, as identified in the TCCE report (2007), contains some of the important items for consideration when establishing a database.

- Bid Item Number,
- Item Description,
- Item Quantity,
- Unit of Work,
- Letting Date,
- Low Bidder Amount,
- Second Bidder Amount,
- Third Bidder Amount,

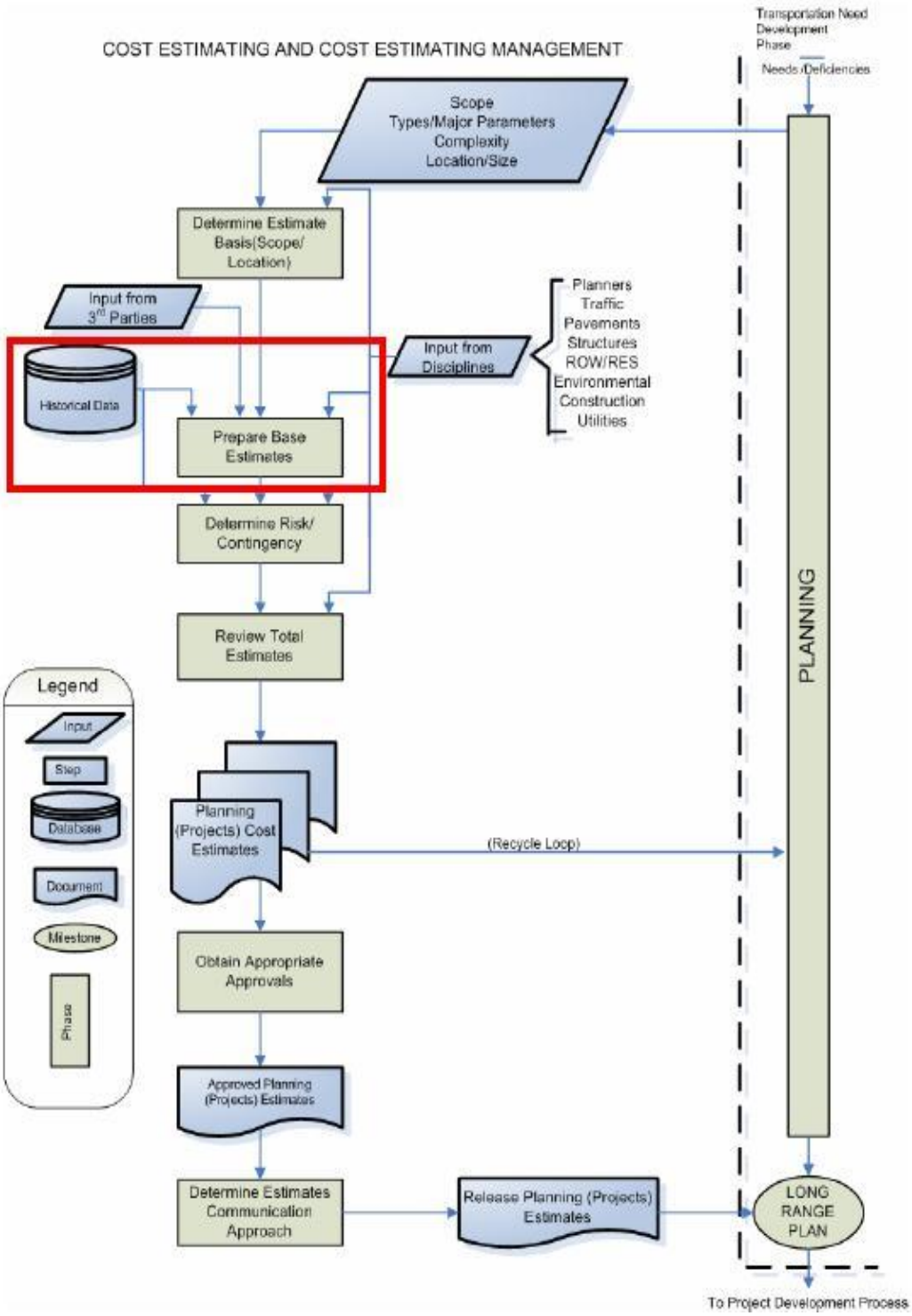



**Figure 1. Cost Estimating During the Planning Phase. (NCHRP 2007)**

- Average Bid,
- Estimated Unit Price, and
- Project Number.

An important factor that is considered when historical unit prices are stored is the number of bids. Schexnayder et al. (2003) report the results for number of bids used in establishing the average prices.

- Low bid only – 20 DOTs
- Low and second bid – 1 DOT
- Three lowest bids – 15 DOTs
- All bids (but may exclude single bids that are very high or low) – 11 DOTs
- All bids except high and low – 2 DOTs
- Bid analysis to determine a reasonable bid amount for each line item – 1 DOT

Further, their study identified that using three low bids for each item produced the best results, while using all bids produced the worst.

State agencies make these historical averages available for their estimators to use. This can be in the form of a simple Excel spreadsheet containing all the historical bid details to a sophisticated computer system. Figure 2 shows sample historical bid data maintained by New York State Department of Transportation (NYSDOT 2008a) on its website as a simple PDF file.

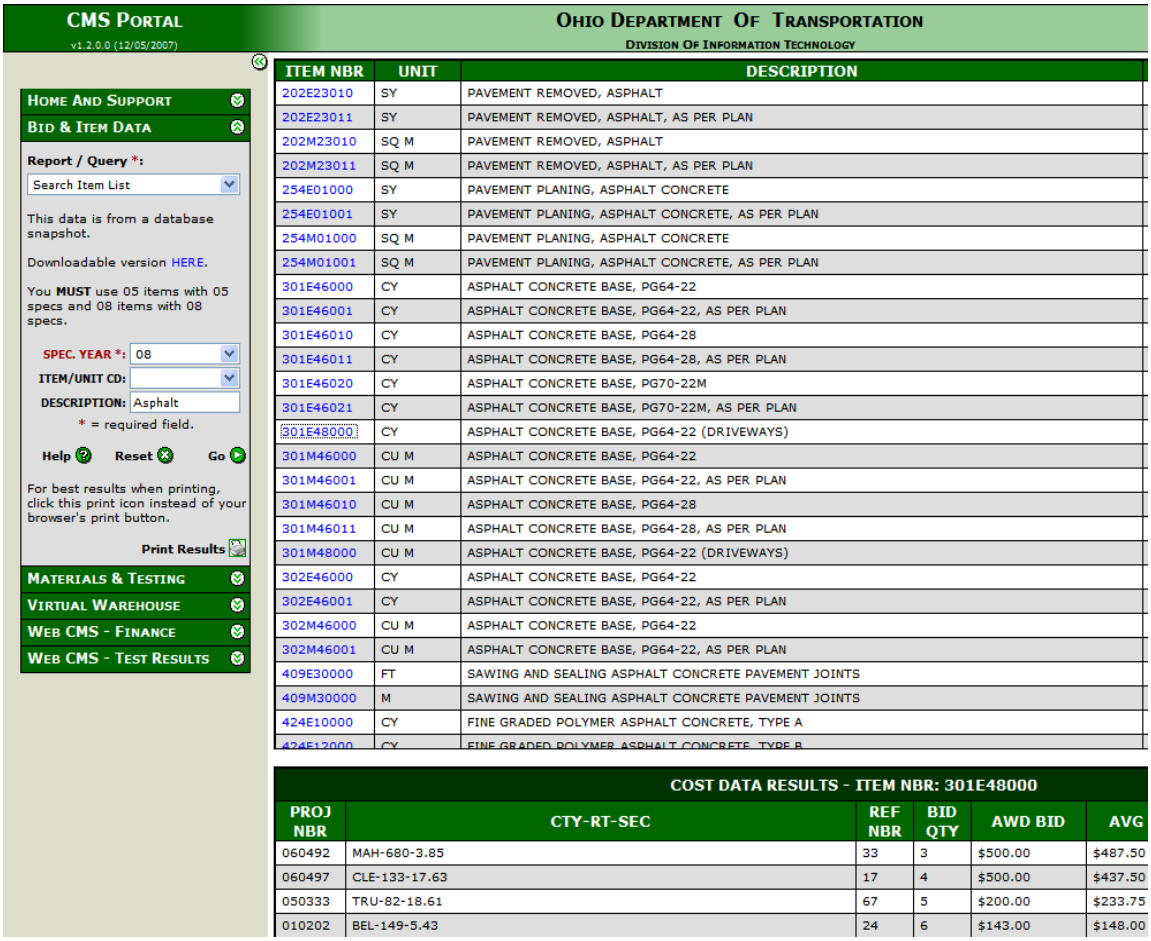
New York State Department of Transportation 10:40 Wednesday, March 26, 2008
Contracts Let January 1, 2007 to December 31, 2007

WEIGHTED AVERAGE ITEM PRICE REPORT
BY ITEM, REGION AND QUARTER

| ITEM | REGION | CALENDAR QUARTER | NUMBER OF OCCUR'S | TOTAL QUANTITY | TOTAL DOLLARS | AVERAGE AWARDED PRICE | AVERAGE OF LOW 3 BIDDERS |
|---|---|---|---|---|---|---|---|
| UNCLASSIFIED EXCAVATION AND DISPOSAL / CM | | | | | | | |
| 203.02 | 03 | 2007Q3 | 3 | 1,911.00 | $48,596 | $25.43 | $35.91 |
| | | 2007Q4 | 1 | 1,610.00 | $19,320 | $12.00 | $16.33 |
| | 04 | 2007Q1 | 5 | 31,546.00 | $357,380 | $11.33 | $12.32 |
| | | 2007Q2 | 7 | 85,380.00 | $1,444,194 | $16.91 | $18.04 |
| | | 2007Q3 | 4 | 100,540.00 | $1,339,174 | $13.32 | $12.21 |
| | | 2007Q4 | 2 | 625.00 | $16,085 | $25.74 | $20.41 |
| | 05 | 2007Q1 | 1 | 50,389.00 | $1,310,114 | $26.00 | $22.50 |
| | | 2007Q2 | 5 | 109,674.00 | $952,135 | $8.68 | $12.07 |
| | | 2007Q3 | 4 | 7,095.00 | $68,919 | $9.71 | $92.75 |
| | | 2007Q4 | 3 | 207,946.00 | $1,878,940 | $9.04 | $10.92 |
| | 06 | 2007Q1 | 3 | 1,109,163.00 | $6,133,544 | $5.53 | $5.32 |
| | | 2007Q2 | 7 | 7,335.00 | $113,584 | $15.49 | $15.51 |
| | | 2007Q3 | 1 | 27,795.00 | $118,129 | $4.25 | $7.88 |
| | | 2007Q4 | 1 | 722.00 | $10,830 | $15.00 | $23.50 |
| | 07 | 2007Q1 | 1 | 200,159.00 | $2,401,908 | $12.00 | $14.17 |
| | | 2007Q2 | 2 | 119,693.00 | $458,161 | $3.83 | $5.72 |
| | | 2007Q3 | 1 | 1,650.00 | $39,600 | $24.00 | $23.17 |
| | 08 | 2007Q1 | 5 | 12,968.00 | $248,374 | $19.15 | $37.64 |
| | | 2007Q2 | 7 | 15,483.00 | $669,998 | $43.27 | $46.89 |
| | | 2007Q3 | 3 | 3,654.00 | $163,962 | $44.87 | $75.27 |
| | | 2007Q4 | 3 | 12,320.00 | $337,100 | $27.36 | $28.57 |
| | 09 | 2007Q1 | 2 | 34,552.00 | $285,756 | $8.27 | $16.14 |
| | | 2007Q2 | 5 | 19,450.00 | $366,515 | $18.84 | $21.49 |
| | | 2007Q3 | 2 | 5,048.00 | $78,339 | $15.52 | $19.30 |
| | | 2007Q4 | 5 | 4,821.00 | $254,246 | $52.74 | $49.50 |
| | 10 | 2007Q1 | 8 | 51,384.00 | $2,087,477 | $40.63 | $35.38 |
| | | 2007Q2 | 5 | 8,056.00 | $133,335 | $16.55 | $25.99 |
| | | 2007Q3 | 1 | 1,733.00 | $216,625 | $125.00 | $145.00 |
| | | 2007Q4 | 2 | 353.00 | $55,470 | $157.14 | $150.56 |

**Figure 2.NYSDOT Average Price Report. (NYSDOT 2008a)**

On the other hand, Caltrans and Ohio Department of Transportation (ODOT) use sophisticated computer systems that allow the estimators to search unit price based on the districts, maximum and minimum quantity, and maximum and minimum total price for an item. Figure 3 shows the Construction Management System (CMS) (ODOT 2008) developed by ODOT for accessing historical bid information.




| ITEM NBR | UNIT | DESCRIPTION |
|---|---|---|
| 202E23010 | SY | PAVEMENT REMOVED, ASPHALT |
| 202E23011 | SY | PAVEMENT REMOVED, ASPHALT, AS PER PLAN |
| 202M23010 | SQ M | PAVEMENT REMOVED, ASPHALT |
| 202M23011 | SQ M | PAVEMENT REMOVED, ASPHALT, AS PER PLAN |
| 254E01000 | SY | PAVEMENT PLANING, ASPHALT CONCRETE |
| 254E01001 | SY | PAVEMENT PLANING, ASPHALT CONCRETE, AS PER PLAN |
| 254M01000 | SQ M | PAVEMENT PLANING, ASPHALT CONCRETE |
| 254M01001 | SQ M | PAVEMENT PLANING, ASPHALT CONCRETE, AS PER PLAN |
| 301E46000 | CY | ASPHALT CONCRETE BASE, PG64-22 |
| 301E46001 | CY | ASPHALT CONCRETE BASE, PG64-22, AS PER PLAN |
| 301E46010 | CY | ASPHALT CONCRETE BASE, PG64-28 |
| 301E46011 | CY | ASPHALT CONCRETE BASE, PG64-28, AS PER PLAN |
| 301E46020 | CY | ASPHALT CONCRETE BASE, PG70-22M |
| 301E46021 | CY | ASPHALT CONCRETE BASE, PG70-22M, AS PER PLAN |
| 301E48000 | CY | ASPHALT CONCRETE BASE, PG64-22 (DRIVEWAYS) |
| 301M46000 | CU M | ASPHALT CONCRETE BASE, PG64-22 |
| 301M46001 | CU M | ASPHALT CONCRETE BASE, PG64-22, AS PER PLAN |
| 301M46010 | CU M | ASPHALT CONCRETE BASE, PG64-28 |
| 301M46011 | CU M | ASPHALT CONCRETE BASE, PG64-28, AS PER PLAN |
| 301M48000 | CU M | ASPHALT CONCRETE BASE, PG64-22 (DRIVEWAYS) |
| 302E46000 | CY | ASPHALT CONCRETE BASE, PG64-22 |
| 302E46001 | CY | ASPHALT CONCRETE BASE, PG64-22, AS PER PLAN |
| 302M46000 | CU M | ASPHALT CONCRETE BASE, PG64-22 |
| 302M46001 | CU M | ASPHALT CONCRETE BASE, PG64-22, AS PER PLAN |
| 409E30000 | FT | SAWING AND SEALING ASPHALT CONCRETE PAVEMENT JOINTS |
| 409M30000 | M | SAWING AND SEALING ASPHALT CONCRETE PAVEMENT JOINTS |
| 424E10000 | CY | FINE GRADED POLYMER ASPHALT CONCRETE, TYPE A |
| 424E12000 | CY | FINE GRADED POLYMER ASPHALT CONCRETE, TYPE B |

**COST DATA RESULTS - ITEM NBR: 301E48000**

| PROJ NBR | CTY-RT-SEC | REF NBR | BID QTY | AWD BID | AVG |
|---|---|---|---|---|---|
| 060492 | MAH-680-3.85 | 33 | 3 | $500.00 | $487.50 |
| 060497 | CLE-133-17.63 | 17 | 4 | $500.00 | $437.50 |
| 050333 | TRU-82-18.61 | 67 | 5 | $200.00 | $233.75 |
| 010202 | BEL-149-5.43 | 24 | 6 | $143.00 | $148.00 |

**Figure 3. ODOT Construction Management System. (ODOT 2008)**

## SUMMARY

The availability of few literatures defining a standardized approach to unit cost development suggests that there is no single approach to construction unit cost development. The process of defining unit costs is dependent upon the estimating technique used and also the phase is which estimates are prepared. Historical bid based

estimating, cost based estimating, and parametric estimating remain the common estimating techniques used depending on the level of project information available. The unit costs prepared are then adjusted to reflect the project characteristics and site conditions. Estimators rely on powerful estimation software to manage large amount of historical data and develop their unit costs. Agencies follow their own process for preparing unit costs and use different estimating techniques to prepare project estimates. Since the unit cost development process and estimating practices differs among the agencies, it is necessary to investigate as many agencies possible to be able to define a framework for unit cost development.

# CHAPTER III

# RESEARCH METHODOLOGY

The main objective of this research is to define a framework that would standardize the unit cost development process. From the review of literature, it became evident that agencies have different approaches to develop unit costs for project estimation. As a result, it was necessary to understand the state of practice within SHAs for developing unit costs. This chapter gives an overview of the approach adopted in this research to define the framework. Figure 4 explains the sequence of activities leading up to the development of the framework.

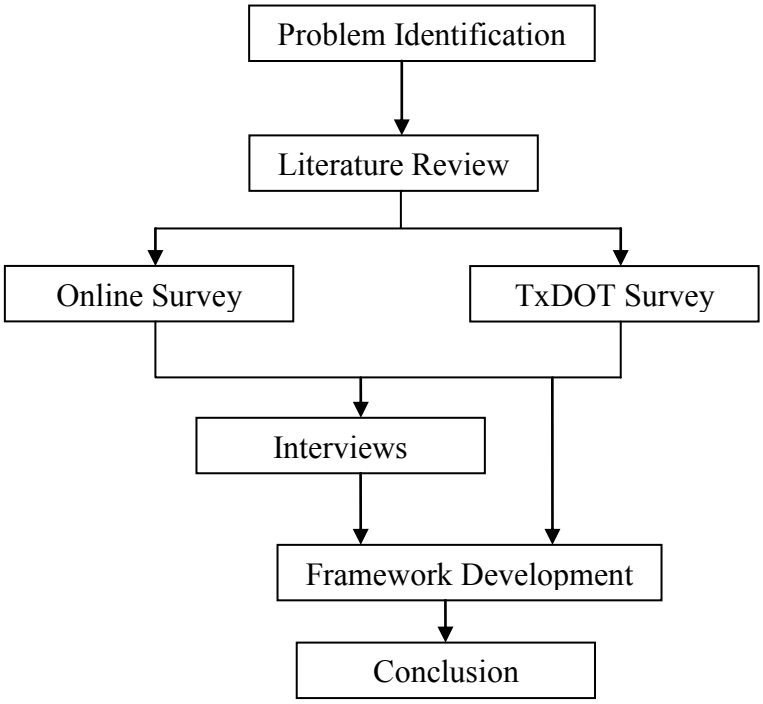



**Figure 4. Research Methodology.**

# METHODOLOGY

Once the project objectives were established, the data needed to address the research questions had to be collected. The review of literature provided an overview of the common estimating techniques used, the estimation guidelines maintained by SHAs, and the information systems available for estimation. But it was apparent that the highway industry had little information published concerning the unit cost development. Because of the scarcity of publications, surveys and interviews were conducted to determine the current state of practice followed by various state agencies for unit cost development.

## Data Collection

Two separate surveys were conducted as during the data collection stage. The first was a survey conducted by TxDOT. This survey consisted of only one question intended to identify agencies having systematic tool to adjust project estimates. This was followed by an online survey developed as part of this research. The online survey was a comprehensive survey covering every aspect of unit cost development. The survey consisted of simple 'Yes/No' type of questions or questions which allowed multiple answers to be selected. The basic information on the state of practice was then acquired from each agency through the survey. The survey questions were pre-tested with two SHAs (Washington and Florida) to ensure questions adequately covered the topic. The survey requests were then sent to the members on the AASHTO Subcommittee of Design and Construction.

The results from the survey were qualitatively analyzed to identify agencies doing considerable work in developing unit costs for project estimation. Selection parameters were drawn up to identify agencies for interviews. These parameters were developed based on the research questions outlined in Chapter I. Interviews were then conducted using a standard interview protocol. The interview protocol consisted of a questionnaire developed based on the replies received for the survey with the purpose of understanding the SHA's unit cost development process better. The questionnaires were sent to respective agencies and interviews were conducted over the telephone and on site. The interview questionnaire followed the same structure as the online survey so that the replies could be easily grouped for analysis and compared with each other.

**Framework Development**

Framework development stage consisted of using the results from the surveys and interviews to define a systematic approach to unit cost development. The framework would have the same structure as the survey and interview questionnaires. The best practices identified from the survey and interview was used to define the characteristics of different components of the framework.

## SUMMARY

The methodology used for the thesis consists of two important activities: 1) data collection (surveys and interviews); and 2) framework development. A survey questionnaire covering different aspects of unit cost development and an interview

protocol was used to obtain information from the SHAs during the data collection activity. Once the interviews were completed, the information was analyzed to develop the framework. Chapters IV, V, and VI explain the data collection and framework development in detail.

# CHAPTER IV

# SURVEY DATA COLLECTION AND ANALYSIS

The most important task in the research was to identify the state of practice within SHAs for developing unit costs for construction projects. Information on the practices followed by other SHAs would be used in creating a framework to support unit cost development. In order to identify the good practices, two surveys were conducted. The first was a single questionnaire survey conducted by TxDOT, and the second was a comprehensive web-based survey conducted by the research team. In this chapter, the first section discusses the TxDOT survey and its results, followed by a discussion of the approach taken for the online survey and its results. The last section outlines the analysis of survey results and the selection criteria used in identifying SHAs for further interviews.

## TEXAS DEPARTMENT OF TRANSPORTATION SURVEY

### Outline

TxDOT's Construction Division conducted a one question preliminary survey on unit price development. TxDOT sent emails to the Construction Engineers in transportation agencies of all fifty states using the AASHTO Subcommittee on Construction database of members. The intent of the question was to identify the process

behind unit price development for estimating projects and possibly for use in change order analysis. The survey question read as follows:

***"Do you have a formal process that uses a systematic tool for developing unit prices that categorizes for issues such as complexity, total quantities, difficulty, and type of project? Please point us to your system on the web or transmit electronically or by mail."***

## Results

Thirty-seven state agencies replied. Though none of the agencies had any formal process for developing unit prices, 14 state agencies used systematic tools for developing unit prices for project estimation. Figure 5 shows the states which responded to the survey and the states which use a systematic tool for unit price development. The following list of states use a systematic tool or have a systematic approach to unit price development.

- California
- Colorado
- Florida
- Illinois
- New Jersey
- New York
- Minnesota
- Massachusetts
- Ohio

- Oregon
- Oklahoma
- Utah
- Virginia
- Washington

Refer to **Appendix A** for the complete list of state agencies and their replies.

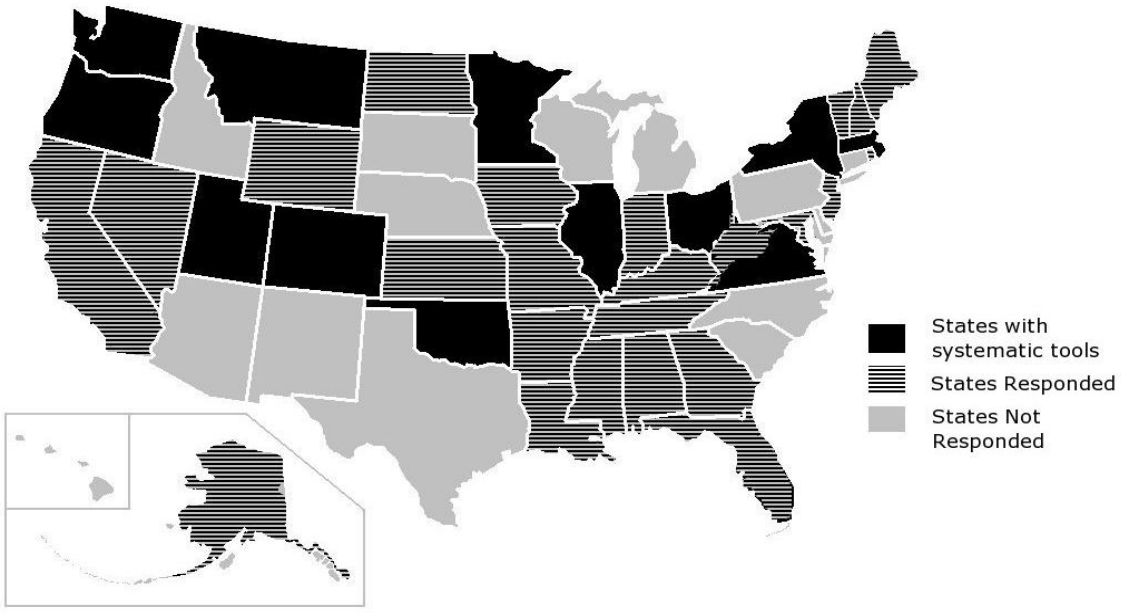



**Figure 5. TxDOT Survey - Participating State Agencies.**

The replies received for the TxDOT survey showed that the state agencies using a systematic tool to develop unit prices were referring to their estimating technique and the computer system used to prepare their final Engineer's Estimate. No state agencies that replied to the survey had a formal process to adjust unit prices for project type and

complexity. The impact on unit prices due to project type and complexity was determined based on the knowledge and experience of the estimator.

## ONLINE SURVEY

### Survey Approach

As part of the research, an online survey approach was used to determine the state of practice within SHAs regarding the development of unit prices for construction projects. This survey identified SHAs conducting considerable work in unit price development. The online survey was conducted using a web-based survey tool called Zoomerang® and request for participation was sent to the Offices of Construction and Design in all the state agencies using the list of contacts from AASHTO Subcommittees on Design and Construction. In total 104 survey requests were sent as part of the online survey.

### Survey Structure

As part of the research, a questionnaire was formulated to identify good practices specifically on unit cost development. The survey questionnaire addressed the unit cost information for construction projects.

Construction Unit Cost section was divided further into following five sub-sections in order to cover all aspects of developing construction unit cost development.

- **General Section** - Focuses on identifying whether the state agency has a structured construction unit cost database and unit cost development procedure in place.

- **Acquiring Unit Cost Information** - Identifies the use of any system that extracts unit cost information from the past contract details and stores them in a cost database.
- **Storing Unit Cost Information** - Focuses on how the unit cost details are stored in the database.
- **Accessing Unit Cost Information** - Identifies the presence of any mechanism to access historic unit cost information.
- **Applying Unit Cost Information** - Focuses on the use of the unit cost information in the estimation process.

The complete questionnaire is given in Appendix B.

General Section

This section identifies the primary estimation technique used by a state agency when estimating a construction project and the tools used for estimation. Respondents chose between the traditional bid-based estimation and the cost-based estimation methods. One of the objectives of this research was to identify the development of unit prices in different phases of the project. For this purpose, the agencies were asked to identify the estimation technique along with the tools used in various project phases. The four phases identified for use in the questionnaire are:

- Planning – concept definition to support a 20-year long range plan;
- Scoping – basic scope definition to place a project into a priority program (10 years or less from the project letting date);

- Design – development of plans and specifications to support a project in the State Transportation Improvement Program (4 years or less from the letting date); and
- PS&E – final plans and specifications to support an Engineers' Estimate for letting a project for construction.

Though the above four phases are different from the phases identified in the literature of this research, they are similar in definition. Agencies like VDOT, WSDOT, and Penn DOT are familiar with the above representation and refer to these four phases in their estimation manual. Only very few agencies use the other notation for referring to the project phases. Hence, as part of this research, the above phases were used to define the project phases.

Agencies listing cost-based estimation as their primary estimation technique were further required to identify different parameters, like the actual production rates and crew sizes, current material costs, and actual equipment rates that they tracked periodically. The survey also asked agencies to provide the names of the computer based system (Commercial or In-house) used for estimation in all four phases of project development. This section also included questions to identify the state agencies having a well-documented process or procedure for developing unit costs for construction cost estimating and whether or not innovative techniques for developing unit costs for construction cost estimating were used. Figure 6 presents the flow of questions in the General section of the survey.

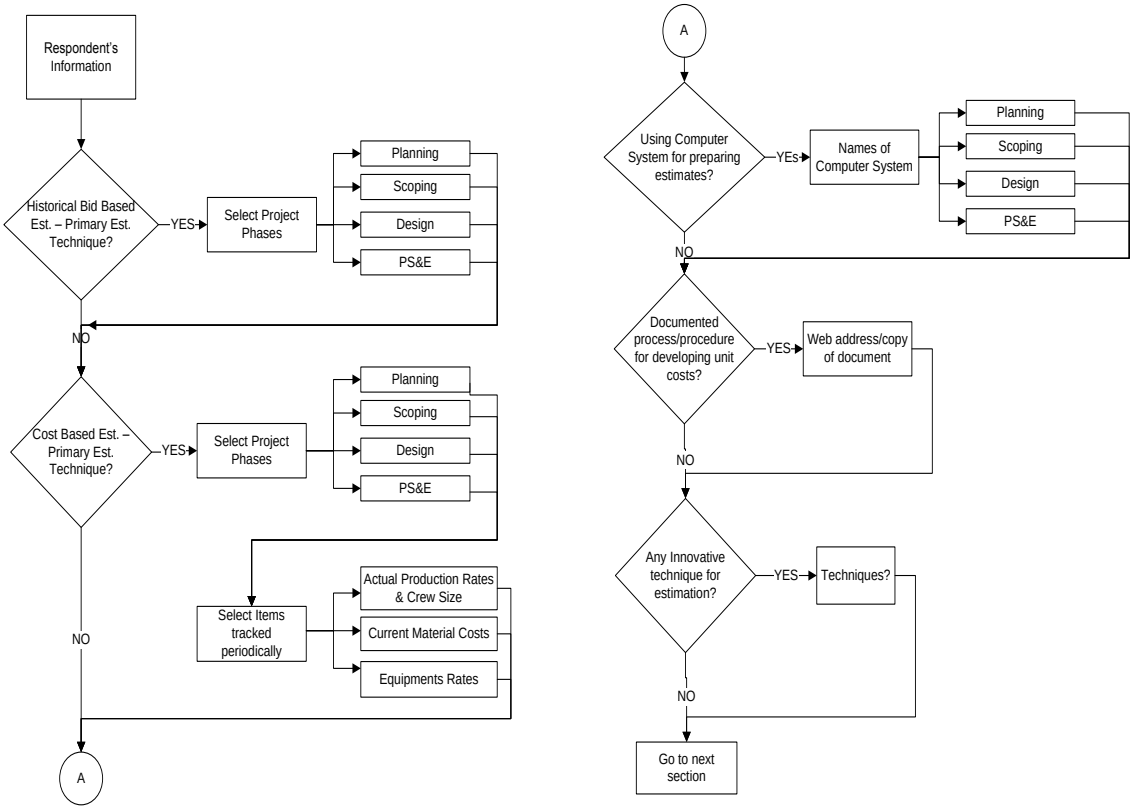



**Figure 6. Flowchart - General Section.**

Acquiring Unit Cost Information

The acquiring unit cost section of the survey captured the system (Commercial or In-house) used by the state agencies to extract unit cost information from the submitted bids and store them in a database. The section also captured the type of historical bid data acquired from the submitted bids to be stored in the database. Figure 7 shows the flow of questions for this section.

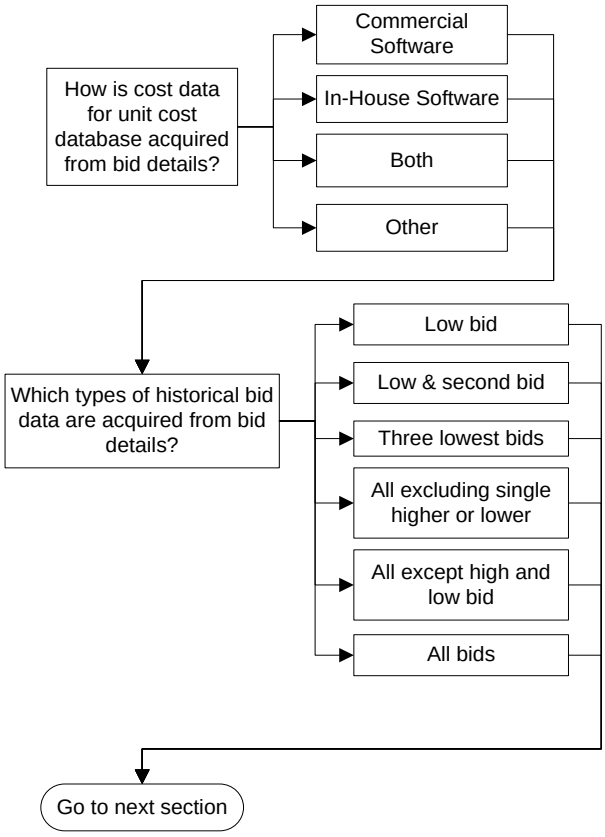



**Figure 7. Flowchart - Acquiring Unit Cost Information.**

Storing Unit Cost Information

Storing unit cost information section focused on how the unit cost details are stored in the database. This involves identifying the type of system (Commercial or In-house, internet or intranet, or Spreadsheet) used to store the historical unit costs and the duration for which these historical unit costs remain in the database. This section also identified whether the unit costs were available for the entire state, districts/regions, counties or market areas and the form in which these unit cost details were stored, either as standard construction line items or based on different work categories or project types. Figure 8 shows the flow of questions for this section.

Accessing Unit Cost Information

This section of the survey captured the ways in which historical unit costs can be accessed within the state agency. This infrastructure includes any system (Commercial or In-House) used by the state agency to sort and summarize historical unit cost data based on the input parameters like standard line item number, quantities, and time period. Figure 9 presents the flow of questions for this section of the survey.

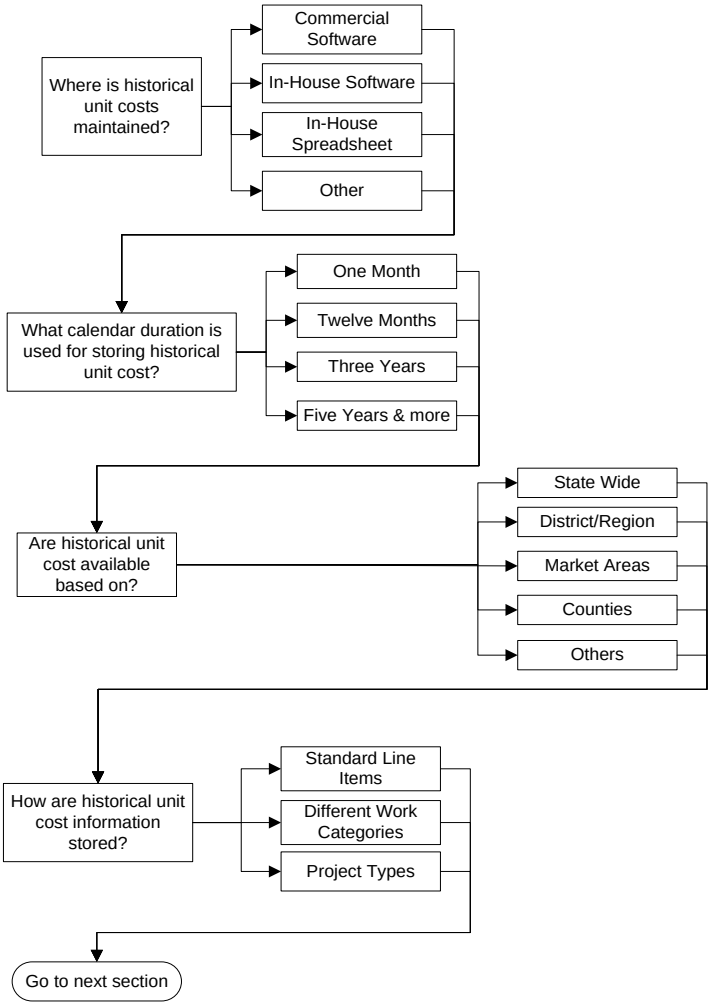



**Figure 8. Flowchart - Storing Unit Cost Information.**

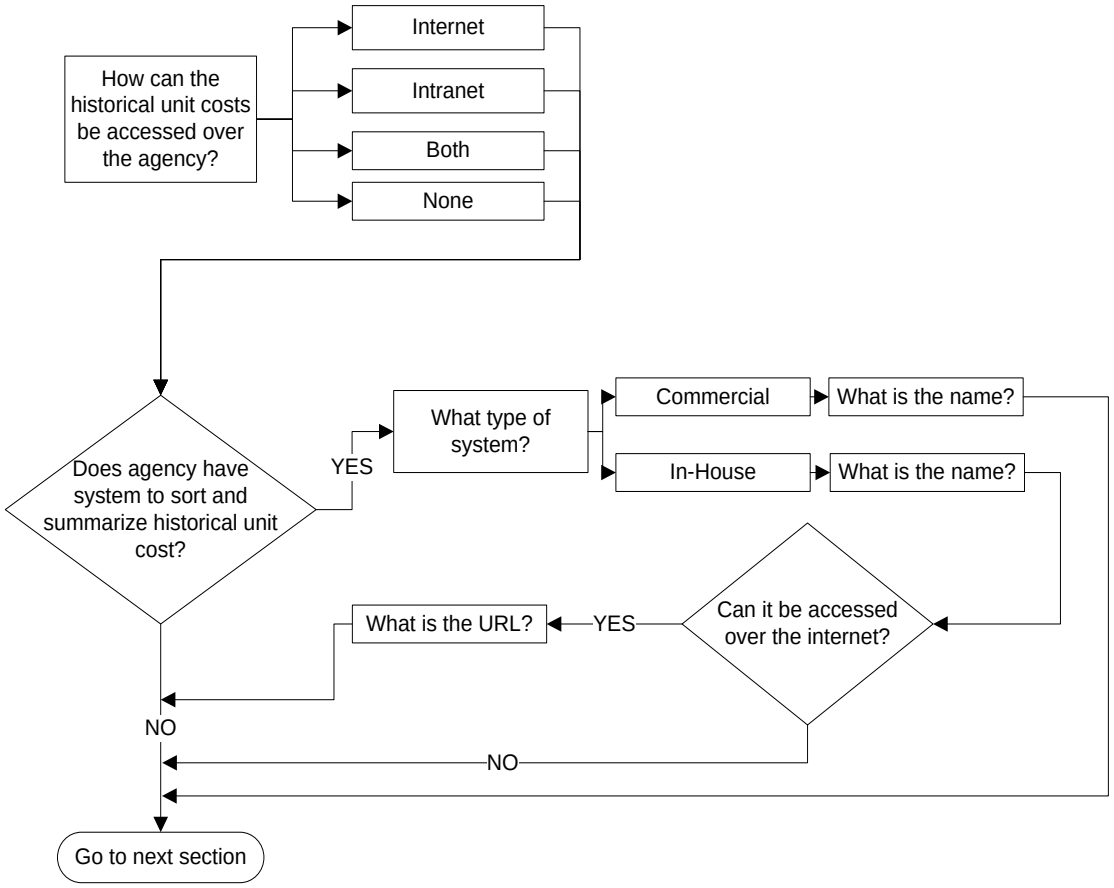



**Figure 9. Flowchart - Accessing Unit Cost Information.**

Applying Unit Cost Information

The final section of the Construction Unit Cost section focused on application of unit cost information in the estimation process. This section identified the calendar duration over which the historical unit costs are averaged, the type of statistical technique used to determine the unit prices, and the items of work (major or minor or both) to which these techniques are applied. This section also identified the state agencies using moving averages as part of their estimation process, the type of moving average used (Simple or Weighted), and the duration considered. The final three

questions of this section captured the state agencies having a documented process or method for adjusting unit prices for project characteristics, current market conditions, and current day prices. Figure 10 presents the flow of questions for this section of the survey.

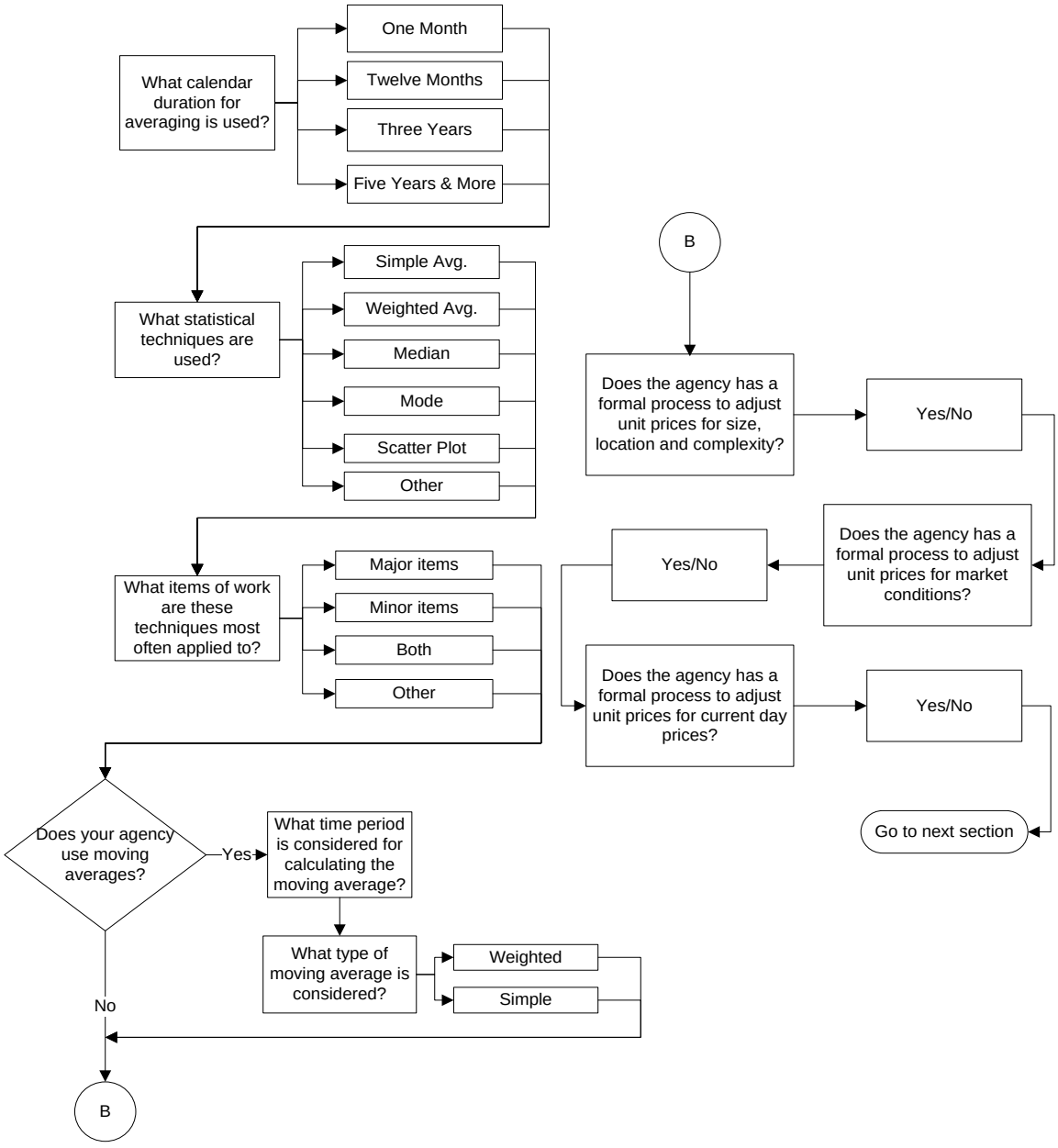



**Figure 10. Flowchart - Applying Unit Cost Information.**

## ONLINE SURVEY RESULTS

The online survey conducted as part of identifying the state of practice within SHAs for the development of unit prices for construction projects yielded thirty-eight (38) replies from thirty-six (36) different state agencies. Both the Office of Construction and Office of Design for Washington State Department of Transportation and Mississippi Department of Transportation replied. Figure 11 shows the states that responded to the online survey. Also shown are the state agencies with which follow up interviews were held.

The results were categorized based on each section identified in the questionnaire and also based on each state agency which replied to the survey.

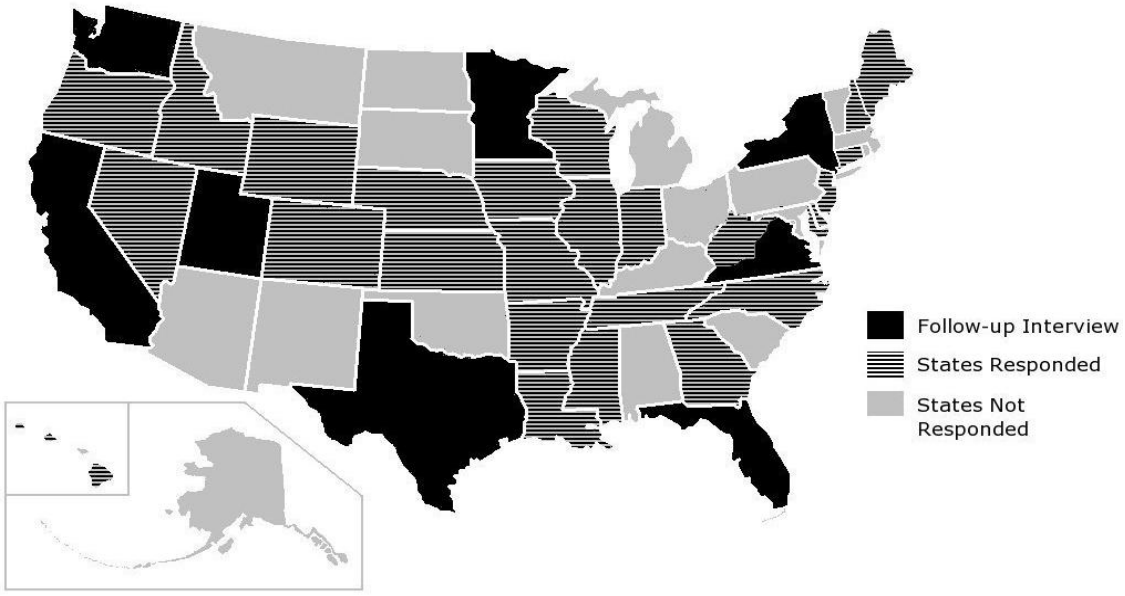



**Figure 11. Online Survey - Participating State Agencies.**

## General Section

The responses received for the general section, which identifies the estimation techniques and tools used by the state agencies for developing unit costs for construction projects gave the following results.

- The majority of state agencies (32) that replied to the survey use the historical bid-based estimation as their primary estimation technique (Figure 12).

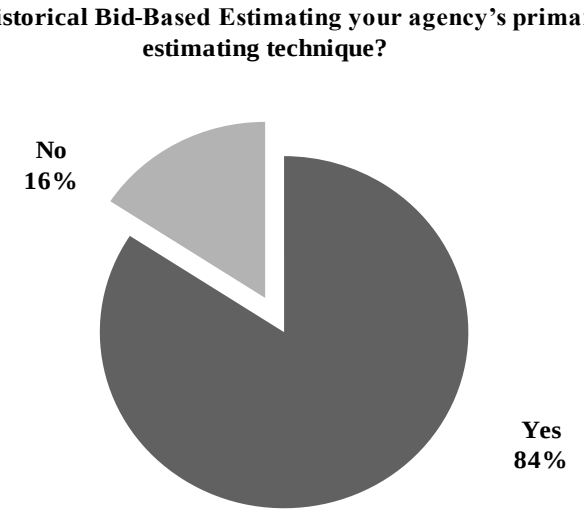



**Figure 12. General Section - Estimating Technique (Bid-Based).**

- The agencies using historical bid-based estimation as their primary estimation technique use it to estimate projects in their Design and PS&E phases. Some agencies use the bid-based estimation approach even in the Planning and Scoping phase of project development (Figure 13).

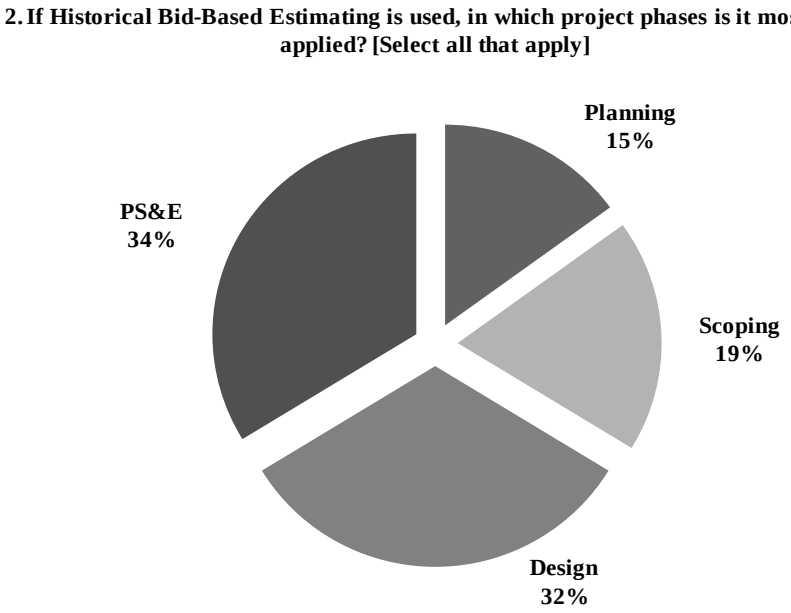



**Figure 13. General Section - Application of Bid-Based Estimating Technique.**

- When it comes to the use of cost-based estimation technique, only 10 state agencies listed cost-based estimation as their primary estimating technique, as shown in Figure 14. Most states apply this technique in the PS&E phase of project development, and some states use it in the Design as well as Scoping phases. No states reported using it in the Planning phase, as shown in Figure 15.

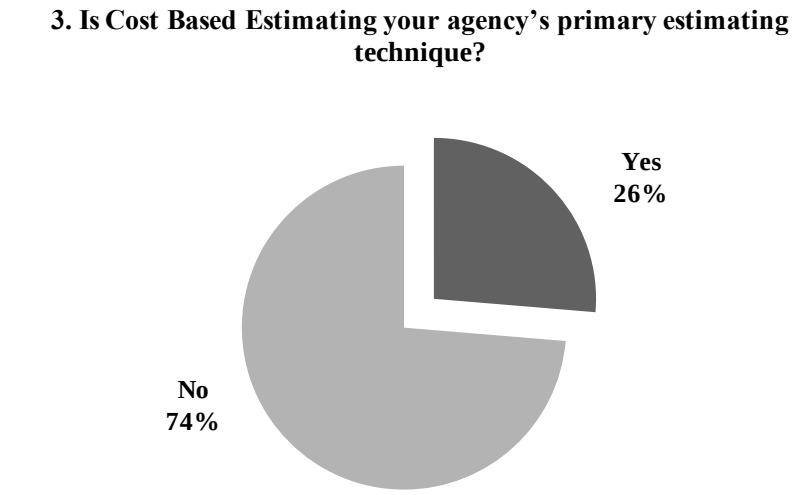



**Figure 14. General Section - Estimating Technique (Cost-Based).**

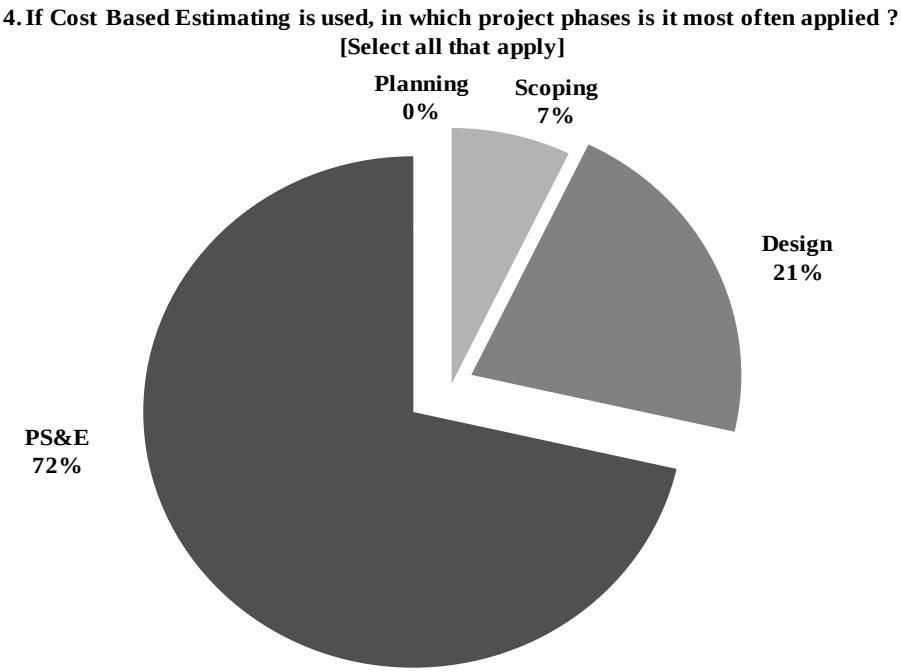



**Figure 15. General Section - Application of Cost-Based Estimating Technique.**

On the question of having a well documented process or procedure for developing unit costs for construction cost estimating, more than half of the agencies replied negatively, as shown in Figure 16. Some agencies which had answered 'Yes' for this question, when interviewed, replied that they did not have any formal documentation on the development of unit costs.

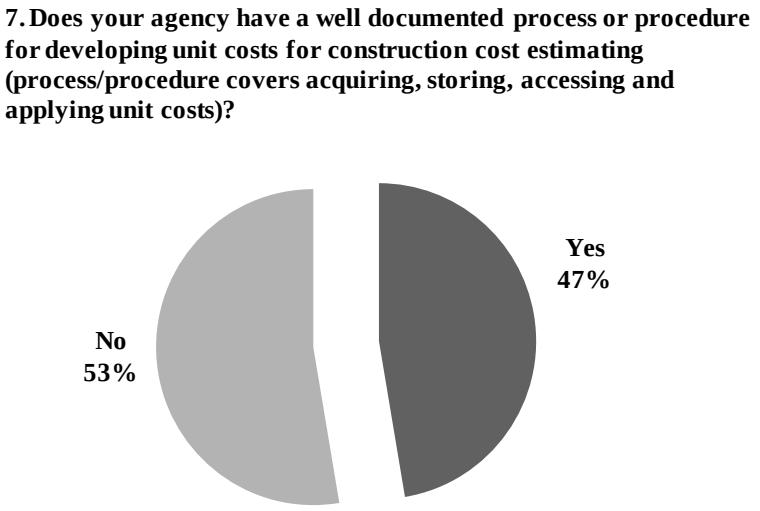



**Figure 16. General Section - Documented Process/Procedure for Unit Cost Development.**

## Acquiring Unit Cost Information

The responses to the section on acquiring unit cost information showed that most of the state agencies use commercial software to acquire data from the bid tabulations, as shown in Figure 17. Some state agencies like California Department of Transportation (Caltrans), Utah Department of Transportation (UDOT) and Texas Department of Transportation (TxDOT) have their own systems to acquire and store bid information.

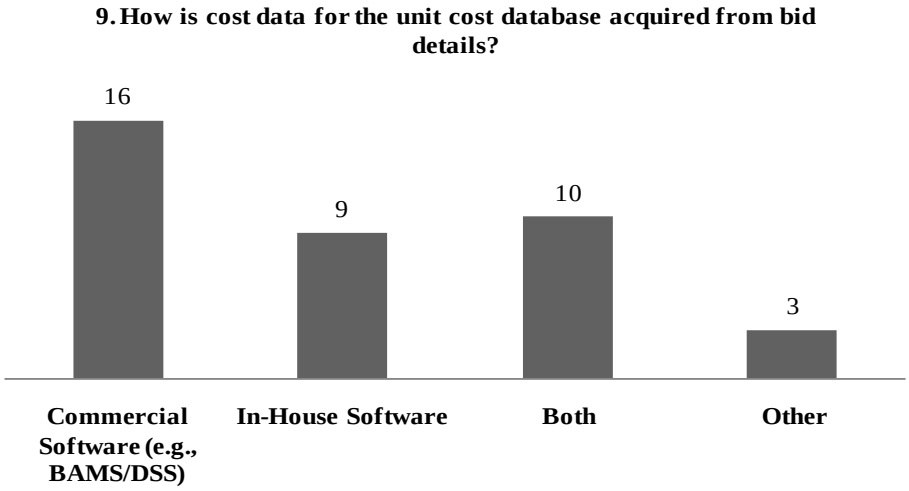



**Figure 17. Acquiring Unit Cost - Extracting of Bid Details.**

Twenty of the thirty-eight state agencies which responded to the survey considered using all the submitted bids for storing in the database (Figure 18). This enabled the agency to assess the price range for various items of work in the submitted bids.

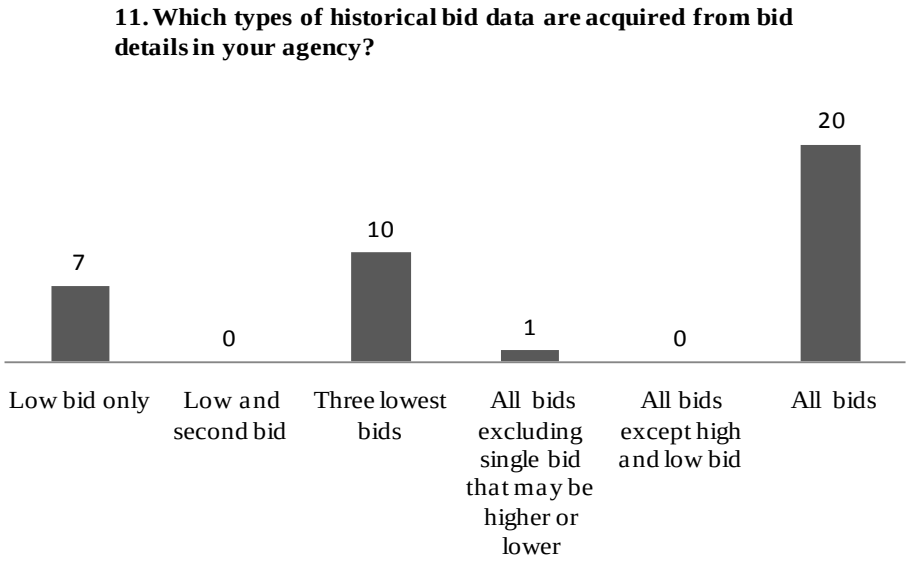



**Figure 18. Acquiring Unit Cost - Types of Historical Bid Data.**

## Storing Unit Cost Information

The survey responses for the Storing Unit Cost section showed that 26 state agencies of the 38 that replied used commercial computer system like BAMS/DSS to store the unit cost information. The majority of the state agencies had more than five years of historical data stored in the database. These historical data were available mostly for the entire state and districts/regions, with a few state agencies like Caltrans, Florida Department of Transportation (FDOT), and Colorado Department of Transportation (CDOT) storing it based on market areas. Market area is a group of counties within district having a similar bidding practice. Standard construction line items was the most popular form of storing these historical unit costs (Figure 19).

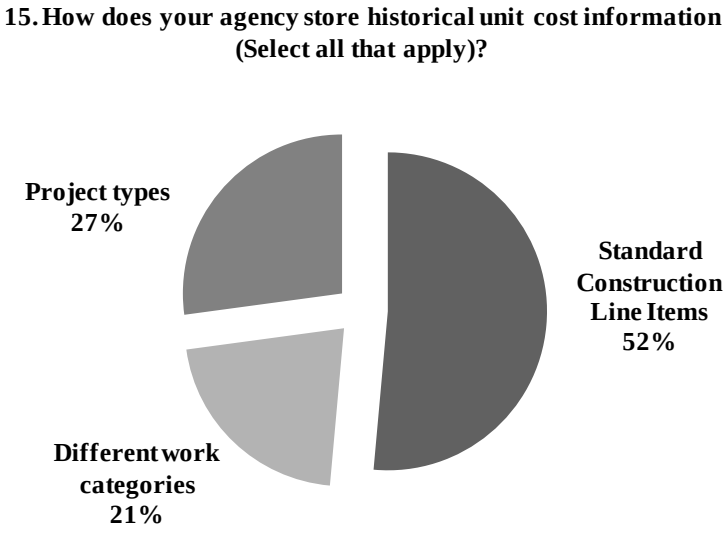



**Figure 19. Storing Unit Cost - General Form of Storing Unit Costs.**

**Accessing Unit Cost Information**

The responses to the Accessing Unit Cost section showed that state agencies maintain historical unit costs on the internet (SHAs' website) as well as on their intranet. In order to access the historical unit costs, 28 state agencies have systems capable of sorting and summarizing the historical unit costs based on such grouping as line item number, quantity range, time period, and source of funding.

**Applying Unit Cost Information**

Based on the response received from the state agencies, following results were observed for the Applying Unit Cost section.

- State agencies consider more than 12 months of historical data to establish the unit prices for cost estimating as shown in Figure 20 below.

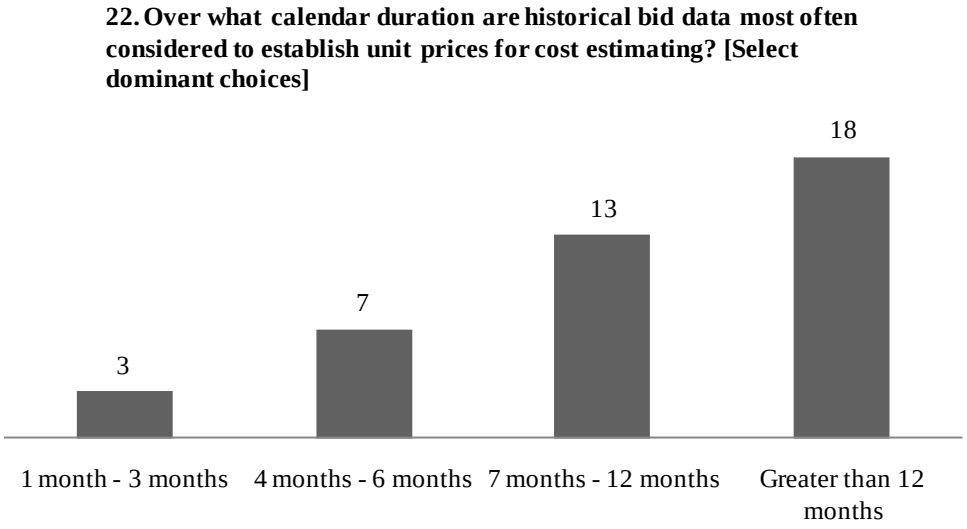



**Figure 20. Applying Unit Cost - Calendar Duration for Unit Prices.**

- Statistical technique most commonly used in determining the unit prices for cost estimating is the weighted average followed by equal number of agencies using simple averages and regression analysis for determining the unit prices (Figure 21). Weighted average is the preferred statistical technique since it takes into consideration the effects of quantities on unit prices. Agencies applied these techniques to both major and minor items of work.

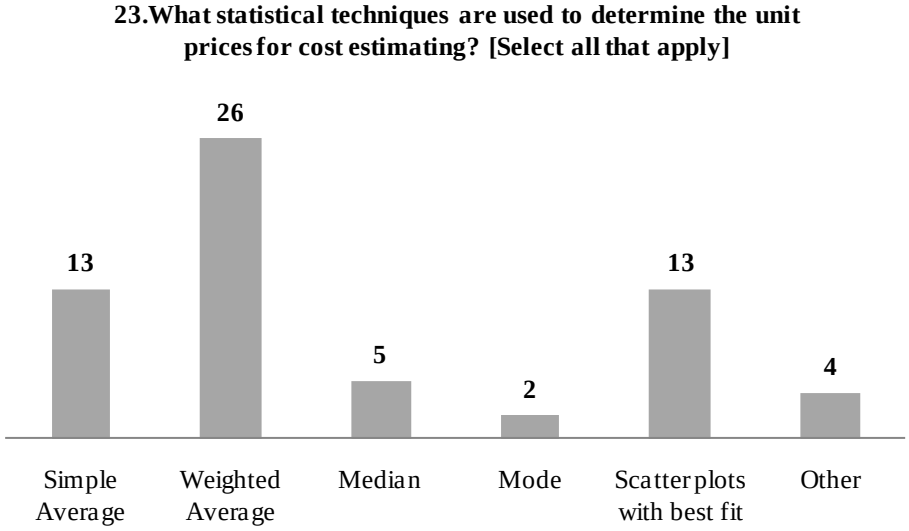



**Figure 21. Applying Unit Cost - Statistical Technique for Cost Estimating.**

- A fewer number of agencies have any formal process or method to adjust unit prices for project characteristics (e.g., complexity, location, size), current market conditions (e.g., bidding environment) or current day prices (e.g., inflation) as shown in Figure 22, Figure 23, and Figure 24 respectively. Table 1 lists the agencies that have a formal process or method for adjusting unit prices.

**Table 1. State Agencies with Formal Process for Adjusting Unit Prices.**

| State Agencies | Formal Process/Methods (Documented) for adusting unit prices based on | | |
|---|---|---|---|
| | Project Characteristics (Complexity, Size) | Current Market Condition | Current Day Prices |
| California | X | X | X |
| Colorado | X | X | X |
| Hawaii | | | X |
| Minnesota | X | | X |
| New Hampshire | X | | |
| Oregon | X | X | X |
| Utah | X | X | X |
| Wisconsin | X | | |

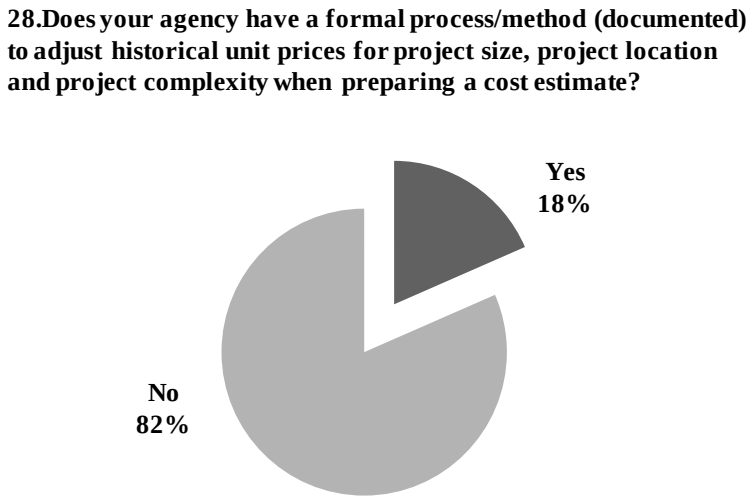



**Figure 22. Applying Unit Cost - Unit Price Adjustment (Project Characteristics).**

**29.Does your agency have a formal process/method (documented) for adjusting the unit prices to reflect the current market condition (e.g., bidding environment)?**

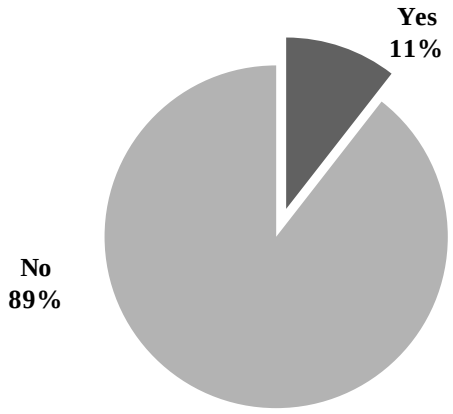



**Figure 23. Applying Unit Cost - Unit Price Adjustment (Current Market Conditions).**

**30.Does your agency have a formal process/method (documented) for adjusting historical unit prices to reflect the current day prices (i.e., impact of inflation)?**

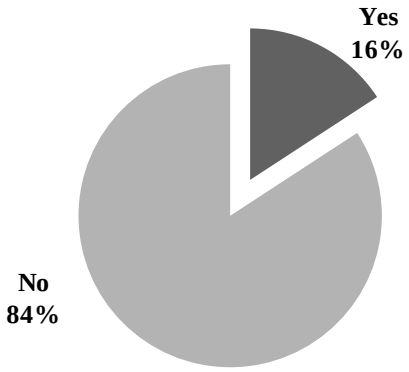



**Figure 24. Applying Unit Cost - Unit Price Adjustment (Current Day Prices)**

## ANALYSIS OF RESULTS

The results from the online survey were analyzed to identify the state agencies conducting considerable work in the development of unit costs for project estimation. The analysis involved identifying the frequency at which an answer was specified for each section of the survey. The data analysis helped to identify SHAs having outstanding existing practices and procedures for unit cost development. The following sections outline the factors used in selecting agencies for further interviews and the list of agencies of agencies selected.

### Interviews – Selection Criterions

The criteria applied to select state agencies for the follow-up interviews covered different aspects of unit cost development for construction projects. They included:

- **Estimating approach** – Type of estimating technique used by the agency in estimating construction projects. Either (1) Historical Bid-Based Estimating or (2) Cost-Based Estimating.
- **Trns*port Users** – Agencies using Trns*port suite of software like CES, PES, Estimator.
- **Non-Trns*port Users** – Agencies using in-house developed system for estimating construction projects.
- **Innovative approach to estimating** – Agencies using innovative ways to estimate construction projects.

- **Sophisticated databases** – Agencies having sophisticated databases for historical unit costs.
- Agencies having guidance on developing estimates for construction projects.

District offices within TxDOT were also considered for interview to gain a better understanding of the unit cost development followed in the districts. The use of above selection factors were driven by the research questions. The estimating approach and guidance on developing estimates will help identify the unit cost development procedure of various agencies. Estimating software and the historical database used by the agencies will focus on gaining information about the tools available for unit cost development. In addition, agencies using innovative ways to estimate would also be identified and explored to obtain more information on innovate ways to develop unit cost.

**Interviews - State Agencies Selected**

Agencies satisfying multiple criterions were identified for a follow-up interview. The following were the eight agencies that were selected for follow-up.

- California
- Florida
- New York
- Minnesota
- Utah
- Virginia
- Washington
- Texas (Dallas, Fort Worth, and Bryan Districts)

Washington and Virginia were selected for their use of cost based estimating technique and also for having guidance on preparing estimates. In addition to having a guidance on developing estimates, Utah was selected for its use of a sophisticated estimating system, completely developed in-house and for adopting innovative ways to develop unit costs. Caltrans is the other agency also to have an estimating system developed in-house. Minnesota was selected for its use of cost based estimating technique and also for being an extensive Trns*port user like NYSDOT. Florida, in addition to having an in-house developed system for preparing preliminary estimates, was selected along with Texas for its use of Trns*port suite of software with their in-house estimating system.

## SUMMARY

The main focus of this synthesis is to explore the various aspects of construction cost development. This includes details on estimating techniques used, use of historical data for arriving at a unit price, and the information systems used for developing construction unit cost information. The online survey helped to determine the state of practice within SHAs for developing construction costs. The survey structure ensured that different aspects of unit cost development were captured. The analysis of results revealed agencies doing considerable work in unit cost development. Eight such agencies were selected based on the selection criterions for further follow-up interviews.

# CHAPTER V

# INTERVIEW DATA COLLECTION AND RESULTS

The interview data collection involved the development of a structured interview protocol. The interview protocol consisted of developing a follow-up questionnaire in order to understand in detail the agency's unit cost development process. The questionnaire was divided into five sections, like the survey and questions were developed based on their replies to the online survey. The interviews were conducted over the telephone for all state agencies except Minnesota Department of Transportation (MnDOT) which was conducted on site. Appendix D shows the sample questionnaire used for the telephone interview with the VDOT. In order to understand the unit cost development process within TxDOT, district offices at Dallas, Fort Worth, and Bryan were selected for interview. The Dallas and Fort Worth interviews were conducted over the telephone, while the Bryan District interview was conducted on site.

## INTERVIEW RESULTS

This section consolidates the replies received from the SHAs interviewed over the telephone or by personal visit to their offices. Similar to the survey, construction unit cost information section is further divided into five sub-sections: 1) a general section; 2) acquiring; 3) storing; 4) accessing; and 5) applying unit cost information.

**Virginia Department of Transportation**

General Section

VDOT's primary estimation technique is cost-based estimating carried out in the PS&E phase of project development. VDOT uses cost-based estimating to develop project estimates using a production rate and the cost associated with labor, materials, and construction equipment. By estimating the cost of each component required to complete the work together with a contractor's profit and overhead an estimated unit price for the work is developed. Estimation during the planning, scoping, and design phase is performed with the help of different software which includes the commercially available Trns*port system as well as software developed in-house by VDOT. Table 2 provides details of the software used by VDOT in different phases of project development. Figure 25 provides the cost estimation framework used by VDOT, set against its contract time estimation framework (Williams et al. 2007).

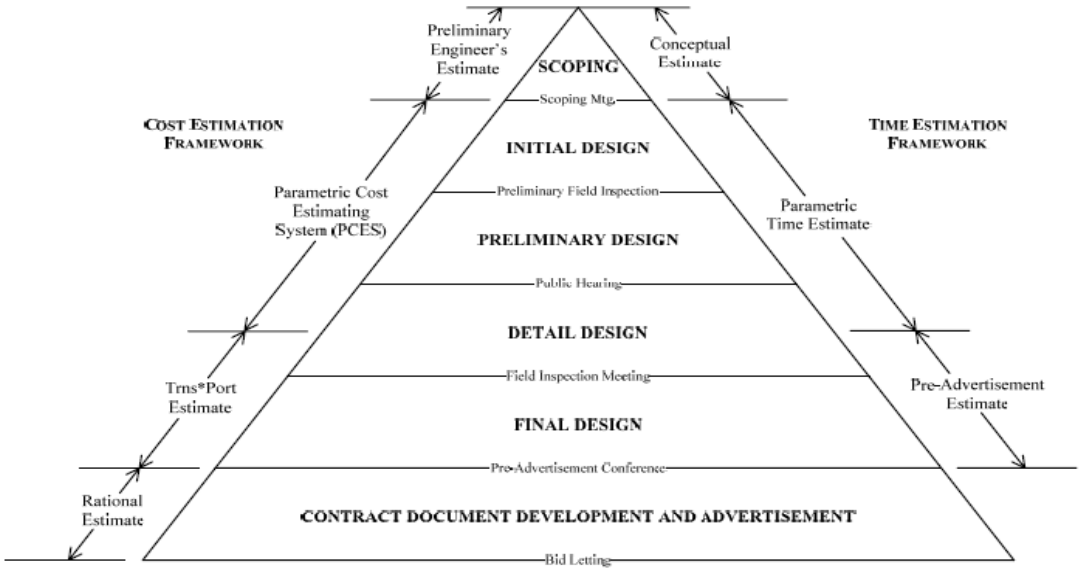



**Figure 25. VDOT Estimation Framework. (Williams et al. 2007)**

**Table 2. VDOT Estimation Software.**

| Project Development Phases | Computer Based System |
|---|---|
| Planning | Planning Cost Estimate Excel |
| Scoping | Project Cost Estimating System (PCES) |
| Design | Trns*port PES |
| PS&E | Estimator, InfoTech Pvt. Ltd |

***Planning Cost Estimate Excel***

The planning division of VDOT uses Planning Cost Estimate Excel to arrive at the planning level cost estimate. This Excel spreadsheet was last updated on June 2006 and is used throughout the state in preparing planning level estimates. This includes cost of typical sections for urban and rural regions, bridge cost, other improvement costs, Right-of-Way (ROW), and Utilities cost (expressed as percentage of construction cost). The estimates are given for three different regions of Virginia. A contingency factor of 20 percent for Preliminary Engineering (PE) and Construction Engineering (CE) is included in the costs. At the planning level, statewide inflation is assumed to be 5.5 percent annually and an inflation rate of 6.5 percent is assumed for Northern Virginia (NOVA)/Hampton roads.

The urban and rural typical section estimates, given in Table 3, do not include bridge, right-of-way (ROW), and other improvement costs. The estimates are represented in Cost Per Mile (CPM). The three regions include Bristol and Lynchburg for Region I, Richmond, Fredericksburg, Culpeper, Salem and Staunton for Region II and NOVA/Hampton Roads for Region III.

**Table 3. Urban/Rural Section - Planning Cost Estimate Excel. (VDOT 2008b)**

| Urban Typical Sections | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bikeway | | 5' pavement | | CPM | $ 490,000 | $ 540,000 | $ 630,000 |
| 2 lanes | U2 | 26'-30' pavement | Reconstruct or New | CPM | $ 2,700,000 | $ 3,000,000 | $ 3,500,000 |
| 3 lanes | U3 | 36'-40' pavement | Reconstruct or New | CPM | $ 5,200,000 | $ 5,700,000 | $ 6,600,000 |
| | | | | | | | |
| 4 lanes | U4 | 40'-48' pavement | Reconstruct or New | CPM | $ 6,200,000 | $ 6,800,000 | $ 7,900,000 |
| 4 lanes divided | U4D | 48' pavement w/16' raised median | Reconstruct or New | CPM | $ 6,900,000 | $ 7,600,000 | $ 8,800,000 |
| 4 lanes divided | U4D | 48' pavement w/28' raised median | Reconstruct or New | CPM | $ 7,400,000 | $ 8,200,000 | $ 9,400,000 |
| | | | | | | | |
| 6 lanes divided | U6D | 72' pavement w/16' raised median | Reconstruct or New | CPM | $ 8,900,000 | $ 9,800,000 | $ 11,300,000 |
| 6 lanes divided | U6D | 72' pavement w/28' raised median | Reconstruct or New | CPM | $ 9,700,000 | $ 10,600,000 | $ 12,300,000 |
| | | | | | | | |
| 8 lanes divided | U8D | 96' pavement w/16' raised median | Reconstruct or New | CPM | $ 11,100,000 | $ 12,200,000 | $ 14,200,000 |
| 8 lanes divided | U8D | 96' pavement w/ 28' raised median | Reconstruct or New | CPM | $ 11,800,000 | $ 12,900,000 | $ 14,900,000 |
| | | | | | | | |
| **Rural Typical Sections** | | | | | | | |
| Bikeway | | 5' pavement | | CPM | $ 220,000 | $ 240,000 | $ 280,000 |
| 1 lane | | 12' pavement | | CPM | $ 300,000 | $ 330,000 | $ 380,000 |
| | | | | | | | |
| 2 lanes | R2 | 18' pavement | Reconstruct or New | CPM | $ 460,000 | $ 500,000 | $ 580,000 |
| 2 lanes | R2 | 20' pavement | Reconstruct or New | CPM | $ 750,000 | $ 830,000 | $ 960,000 |
| 2 lanes | R2 | 22' pavement | Reconstruct or New | CPM | $ 900,000 | $ 990,000 | $ 1,140,000 |
| 2 lanes | R2 | 24' pavement | Reconstruct or New | CPM | $ 1,300,000 | $ 1,400,000 | $ 1,700,000 |
| | | | | | | | |
| 3 lanes | R3 | 36' pavement | Reconstruct or New | CPM | $ 2,600,000 | $ 2,900,000 | $ 3,300,000 |
| | | | | | | | |
| 4 lanes divided | R4D | 48'pavement | Reconstruct | CPM | $ 3,500,000 | $ 3,900,000 | $ 4,500,000 |
| 4 lanes divided | R4D | 48' pavement | New | CPM | $ 5,300,000 | $ 5,900,000 | $ 6,800,000 |
| 4 lanes divided | R4D | 48' pavement | Parallel | CPM | $ 2,700,000 | $ 3,000,000 | $ 3,500,000 |
| 4 lanes divided | R4D | 48' pavement w/16' raised median | Reconstruct or New | CPM | $ 3,800,000 | $ 4,100,000 | $ 4,800,000 |
| 4 lanes divided | R4D | 48' pavement w/28' raised median | Reconstruct or New | CPM | $ 4,400,000 | $ 4,900,000 | $ 5,600,000 |
| | | | | | | | |
| 6 lanes divided | R6D | 72' pavement widen 4-6 lanes | Reconstruct | CPM | $ 4,900,000 | $ 5,400,000 | $ 6,300,000 |
| 6 lanes divided | R6D | 72' pavement w/depress median | New | CPM | $ 6,500,000 | $ 7,100,000 | $ 8,300,000 |
| | | | | | | | |
| 8 lanes divided | R8D | 96' pavement widen 6-8 lanes | Reconstruct | CPM | $ 4,900,000 | $ 5,400,000 | $ 6,300,000 |
| 8 lanes divided | R8D | 96' pavement widen 4-8 lanes | | CPM | $ 9,800,000 | $ 10,700,000 | $ 12,400,000 |

**Table 4. Bridge Cost - Planning Cost Estimate Excel. (VDOT 2008b)**

| Bridge Cost | | | | |
|---|---|---|---|---|
| Over 25' to 200' in length | Widen Reconst or New per sq ft | $ 110 | $ 120 | $ 140 |
| Over 200' in length | Widen Reconst or New per sq ft | $ 140 | $ 150 | $ 170 |

The tool excludes bridges from the typical section since they contribute significantly to construction cost. Estimates for bridge are computed using the available costs per square footage multiplied by the bridge dimensions. Table 4 gives the bridge cost used in the planning level cost estimate.

Other improvement costs are added to construction cost based on the project condition. The urban/rural sections, bridges and other improvement costs make up the planning level construction estimate. The Planning Cost Estimate Excel derives the planning level cost estimate by adding the ROW cost and utilities cost to the construction estimate. The ROW and utilities cost, given in Table 5, are classified based on location of project.

**Table 5. ROW Cost Percentages - Planning Cost Estimate Excel. (VDOT 2008b)**

| Right of Way & Utilities Cost % of Cost Estimate | | |
|---|---|---|
| Rural | 25% | 30% |
| Residential/Suburban low density | 50% | 55% |
| Outlying business/Suburban high density | 60% | 75% |
| Central business district | 100% | 125% |

***Project Cost Estimating System (PCES)***

PCES is an in-house system developed by VDOT for preparing estimates during the scoping phase of project development. The current version of the PCES is 2.5, though the discussion used version 2.1. The PCES consists of following sections:

*Summary Page*

The summary page gives the total project estimate, which is made up of the construction estimate, Preliminary Engineering (PE) estimate, and right-of-way and utilities estimate along with the project number, district, and year of estimation.

*Construction/Bridge/PE*

This section uses lane mile cost for different geometric standards taken from the bid details. The construction estimate includes details of the roadway like the total length of project, length of two/four lanes to be built, length of the curb (ft), length of the sidewalk, number of new traffic signals required or number of signals requiring adjustment, cost of large drainage structures, and in-plan utility cost.

The PCES system provides an estimate based on project features rather than the quantities. For example, the cost of all the components required in constructing a new signal is rolled up into one cost, which constitutes the unit price for the signal. By entering the number of new signals to be constructed, a total estimate for the signals is computed.

PCES estimates bridges separately, again for the same reason that they contribute significantly to project construction cost. The dimensions of the existing and new bridge along with the complexity/type of new bridge are entered for estimating the bridge

construction cost. Bridge complexity can be selected as simple, moderate, or complex based upon the height, difficulty of construction and other factors. Estimates for a bridge of moderate complexity are taken as the base estimate, which is increased by 15 percent for complex bridges and decreased by 10 percent for bridges of simple complexity. Also, PCES provides the option to select whether the bridge work is only widening of existing structure or super structure repair. The demolition of bridges is estimated as a lump sum item.

*Right-of-way (ROW) Estimate*

The costs associated with the ROW estimate can be either "computed" or "user-defined" costs. ROW estimate comprises of the land value, building value, damages, other improvements, administrative settlements, condemnation increases, administrative costs and incidental expenses, demolition contracts, hazardous materials removal, property management, relocation assistance, year of ROW authorization and a manual inflation rate.

*Utilities Estimate*

The utilities estimate includes the cost associated with setting up electrical lines, telephone lines, water, sanitary sewer, natural gas/propane, petroleum, cellular, and any additional items.

***Trns*port Proposal and Estimate System (PES)***

VDOT uses the PES module of the Trns*port system for preparing the design level estimates. PES generates an item cost estimate using the historical bid data stored in the BAMS/DSS. The emphasis at this stage is on estimating the correct quantities.

VDOT uses a detailed estimate generated by PES to compare the estimates generated by the estimators.

***Trns*port Estimator***

VDOT uses the Estimator to perform "rational estimation" or cost-based estimation to compare with the estimates of designers. The definition of rational estimate given by VDOT is "*An estimate prepared by determining the required manpower, equipment, labor, and production rate, per day needed to complete a unit of work.*" Rational estimation is performed on bid items which constitute 65 percent of total project cost. All unit prices are reviewed and modified as necessary. VDOT checks the remaining 35 percent of project cost, which mostly includes minor items of work, against the prices estimated in PES and does not modify the amounts unless there is a large deviation in the prices contained in PES. VDOT uses various catalogs for its rational estimation. These catalogs are databases containing the equipment, labor, and material costs that are loaded into Estimator. The Site Manager module of the Trns*port suite of software is also used in the estimation to obtain production rates based on the similarity of work being estimated.

Acquiring Unit Cost Information

As part of its rational estimation, VDOT makes use of different catalogs. These 'catalogs' are databases of equipment rates, labor and production rates, and material costs loaded into Estimator to help in preparing the cost estimate. These catalogs are updated every year from their respective sources specified in Table 6.

**Table 6. VDOT Source of Equipment, Labor, Material, and Production Rates.**

| | |
|---|---|
| Equipment Costs | Blue Book of Construction Equipment Rental Rates |
| Material Costs | Material on Hand (VDOT form C-22) reports, individual suppliers, and internet |
| Labor rates | Virginia Employment Commission (VEC) |
| Production Rates | RS Means and Site Manager (Trns*port), Bid Item Duration Data System (BIDDS) |

Equipments rates, labor and production rates, and material costs are updated periodically as and when their respective data sources are revised. The State Estimates Officer and Bid Engineer are responsible for verifying the updated catalogs of equipments, labor, and material costs.

Storing Unit Cost Information

VDOT maintains over five years of historical unit costs in its BAMS/DSS database. These historical unit costs are available for the entire state as well as for each district. Apart from storing historical unit costs as standard construction line items, VDOT also categorizes them based on different work categories (e.g., grading/excavation, asphalt, bridge, traffic control, etc.) and based on project types (e.g. bridge replacement, lane widening, intersection reconstruction, etc.). PES project details are updated every night in a separate database. This is used to compare the estimates prepared using PCES software.

Accessing Unit Cost Information

The BAMS/DSS database is the primary source of historical data used in PES and Estimator. VDOT also maintains a comprehensive two-year historical bid price listing as well as the statewide and district averages on its website at http://www.virginiadot.org/business/const/ under the '***Other Resources***' section. Figure 26 provides a sample of a two-year historical bid price listing maintained by VDOT. Figure 27 and Figure 28 give a snapshot of the statewide and district averages maintained for different work items.

Virginia Department of Transportation 14:37 Thursday, May 22, 2008 1
Two Year Bid History
APRIL 2006 through MARCH 2008

HISTORICAL BID PRICE LISTING

PAY ITEM: 00100 DESCRIPTION: MOBILIZATION / LS

| REGION | CALENDAR QUARTER | CONTRACT NUMBER | COUNTY LOCATION | PROJECT DESCRIPTION | BID QUANTITY | AWARD PRICE | SECOND BIDDER | THIRD BIDDER | ESTIMATE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2006Q2 | C00008078C02 | SMYTH | 0610-086-157,C502 | 1 | $50,000 | $125,000 | $50,000 | |
| | | C00018044N01 | TAZEWELL | 0606-092-571,B642 | 1 | $20,000 | $26,500 | $48,000 | |
| | | C00070079C01 | SCOTT | 0058-084-113,C501 | 1 | $151,825 | $296,500 | $425,000 | |
| | | C00070847C01 | WASHINGTON | 0611-095-294,C501 | 1 | $9,500 | $20,000 | $35,000 | |
| | | C00078638N01 | BRISTOL | (NFO)OVHD-961-101,N5 | 1 | $19,485 | $20,000 | $42,100 | |
| | | C00078829N01 | RUSSELL | 0645-083-446,N501 | 1 | $18,000 | $11,635 | $30,000 | |
| | | CM103BRA39543 | SMYTH | 0624-086-6034,SR00 | 1 | $25,000 | $35,490 | $50,000 | |
| | | CM103BRA39623 | BUCHANAN | 0083-013-1026,SR00 | 1 | $29,505 | $50,000 | $18,000 | |
| | | CM105BRA39575 | WISE | 0072-097-1093,SR00 | 1 | $24,500 | $15,000 | $28,000 | |
| | | CM105BRA39659 | DICKENSON | 0072-025-1020,SR00 | 1 | $12,750 | $37,913 | $27,500 | |
| | | CM106BRB39575 | WISE | (NFO)PM06-097-144,M4 | 1 | $150,000 | $325,000 | $151,475 | |
| | | CM106BRB39578 | GRAYSON | BR-1A-06 | 1 | $25,000 | $33,000 | $60,000 | |
| | 2006Q3 | C00013897N01 | SCOTT | 0852-084-241,B632 | 1 | $30,000 | $25,250 | $40,000 | |
| | | C00016906B40 | RUSSELL | 0657-083-346, B640 | 1 | $35,000 | $15,000 | $40,000 | |
| | | C00065067N01 | TAZEWELL | (NFO)0019-092-119,N5 | 1 | $3,000 | | | |
| | | C00071603B25 | BLAND | 0622-010-181,B625 | 1 | $15,250 | $40,000 | $35,000 | |
| | | C00080349N01 | SCOTT | 0370-084-313,N501 | 1 | $17,225 | $25,000 | $25,000 | |
| | | C00080388M00 | WISE | BR07-097-153, M400 | 1 | $42,000 | $69,000 | $167,000 | |
| | | C00080698C01 | BUCHANAN | BR07-013-184, C501 | 1 | $49,000 | $120,000 | $112,100 | |
| | | CM106BRA39537 | SCOTT | 0645-084-6062, SR01 | 1 | $12,000 | $25,000 | $30,000 | |
| | 2006Q4 | C00000313C02 | BUCHANAN | 0680-013-122,C502 | 1 | $94,600 | $200,000 | $900,000 | |
| | | C00018235N01 | DICKENSON | 0650-025-450,N501 | 1 | $55,000 | $20,000 | $30,000 | |
| | | C00018612N01 | SCOTT | 0625-084-P63,N501 | 1 | $12,250 | $12,000 | $25,000 | |
| | | C00018930B04 | WASHINGTON | 0058-095-114,B604 | 1 | $46,500 | $52,300 | $129,000 | |
| | | C00062409N02 | WISE | 0610-097-481,N502 | 1 | $33,300 | $100,000 | $45,000 | |
| | | C00080223M00 | WISE | BR07-097-150,M400 | 1 | $25,000 | $20,000 | $31,000 | |
| | 2007Q1 | C00012500C01 | WASHINGTON | 0736-095-277,C501 | 1 | $60,000 | $83,000 | $120,000 | |
| | | C00051556N01 | RUSSELL | 0635-083-P27,N501 | 1 | $12,500 | $15,120 | $10,000 | |
| | | C00058265N04 | BUCHANAN | 0616-013-P92,N504 | 1 | $26,000 | $12,000 | $30,000 | |
| | | C00058266N01 | BUCHANAN | 0628-013-P56,N501 | 1 | $17,980 | $7,500 | $16,000 | |
| | | C00080215SR2 | SMYTH | 0730-086-630,SR02 | 1 | $106,000 | $105,000 | $121,000 | |
| | | C00080217SR3 | WISE | (NFO)0083-097-104,SR | 1 | $70,000 | $37,800 | $83,000 | |
| | | C00080785N09 | BRISTOL | IS00-961-101,N509 | 1 | $70,000 | $110,750 | $131,000 | |

**Figure 26. VDOT Two-Year Historical Bid Price Listing. (VDOT 2008c)**

STATEWIDE AVERAGES APRIL 2006 THROUGH MARCH 2008

| ITEM | ITEM DESCRIPTION | UNIT | MINIMUM PRICE | MAXIMUM PRICE | AVERAGE LOW BIDS |
|---|---|---|---|---|---|
| 00010 | LABOR | TEC | $ 32.00 | $ 42,000.00 | $ 189.18 |
| 00100 | MOBILIZATION | LS | $ 1.00 | $ 11,500,000.00 | $ 152,515.03 |
| 00101 | CONSTRUCTION SURVEYING | LS | $ 248.50 | $ 4,000,000.00 | $ 91,596.16 |
| 00110 | CLEARING AND GRUBBING | LS | $ 47.50 | $ 1,700,000.00 | $ 227,244.77 |
| 00120 | REGULAR EXCAVATION | CY | $ 3.03 | $ 140.00 | $ 12.22 |
| 00124 | ROCK EXCAVATION | CY | $ 1.00 | $ 600.00 | $ 373.79 |
| 00125 | GRADING | LS | $ 1.00 | $ 826,000.00 | $ 98,509.16 |
| 00126 | EARTHWORK | LS | $ 85,000.00 | $ 170,000.00 | $ 127,500.00 |
| 00128 | EXTRA EXCAVATION | CY | $ 1.53 | $ 30.00 | $ 7.99 |
| 00140 | BORROW EXCAVATION | CY | $ 0.01 | $ 50.00 | $ 10.56 |
| 00150 | EMBANKMENT | CY | $ 0.01 | $ 50.00 | $ 3.78 |
| 00155 | GEOTEXTILE (EMBANKMENT STABILIZATION) | SY | $ 1.65 | $ 5.01 | $ 1.90 |
| 00190 | SURCHARGE PLACEMENT & REMOVAL | CY | $ 63.00 | $ 63.00 | $ 63.00 |
| 00200 | SETTLEMENT PLATE | EA | $ 1,200.00 | $ 1,700.00 | $ 1,311.11 |
| 00211 | MINOR STRUCTURE EXCAV. PIPE CULVERT | CY | $ 5.00 | $ 75.00 | $ 17.41 |
| 00212 | MINOR STRUCTURE EXCAV. BOX CULVERT | CY | $ 11.00 | $ 100.00 | $ 41.75 |
| 00270 | SELECT MATL. TY. I MIN. CBR-30 | TON | $ 11.98 | $ 40.00 | $ 26.02 |
| 00272 | SELECT MATL. TY. I MIN. CBR-30 | CY | $ 23.17 | $ 58.30 | $ 29.00 |
| 00280 | SELECT MATL. TY. II MIN. CBR-20 | CY | $ 12.23 | $ 400.00 | $ 18.09 |
| 00355 | GEOTEXTILE (SUBGRADE STABILIZATION) | SY | $ 0.55 | $ 25.00 | $ 2.19 |
| 00491 | CLASS I BACKFILL MATERIAL | CY | $ 48.02 | $ 48.02 | $ 48.02 |
| 00502 | BED.MAT.FINE AGR.OR AGGR.NO.10 | TON | $ 20.00 | $ 20.00 | $ 20.00 |
| 00505 | BEDDING MATL.AGGR.NO. 25 OR 26 | TON | $ 13.00 | $ 108.34 | $ 27.58 |
| 00515 | TEMPORARY SHEET PILING | SF | $ 9.20 | $ 75.71 | $ 26.79 |
| 00519 | SHEET PILE, STEEL | SF | $ 31.83 | $ 31.83 | $ 31.83 |
| 00522 | CONCRETE CLASS A4 BOX CULVERT | CY | $ 373.25 | $ 1,900.00 | $ 973.76 |
| 00525 | CONCRETE CLASS A3 MISC. | CY | $ 129.50 | $ 6,712.07 | $ 757.83 |
| 00529 | FLOWABLE BACKFILL | CY | $ 50.00 | $ 1,200.00 | $ 117.46 |
| 00530 | CONCRETE CLASS B2 | CY | $ 3,000.00 | $ 3,000.00 | $ 3,000.00 |
| 00540 | REINF. STEEL | LB | $ 0.01 | $ 3.75 | $ 0.90 |
| 00542 | EPOXY COATED REINF. STEEL | LB | $ 0.01 | $ 2.70 | $ 1.68 |
| 00560 | STRUCTURAL STEEL JB-1 | LB | $ 4.68 | $ 25.00 | $ 8.64 |
| 00571 | ENDWALL PIPE GRATE EW-11 TY.I | LF | $ 550.00 | $ 550.00 | $ 550.00 |
| 00574 | ENDWALL GRATE & FRAME EW-11A | EA | $ 950.00 | $ 3,500.00 | $ 2,543.75 |

**Figure 27. VDOT Statewide Averages. (VDOT 2008c)**

DISTRICT AVERAGES APRIL 2006 THROUGH MARCH 2008

| ITEM | ITEM DESCRIPTION | UNIT | MINIMUM PRICE | MAXIMUM PRICE | AVERAGE LOW BIDS | DISTRICT |
|---|---|---|---|---|---|---|
| 00100 | MOBILIZATION | LS | $ 3,000.00 | $ 180,000.00 | $ 41,471.99 | BRSTL |
| 00101 | CONSTRUCTION SURVEYING | LS | $ 3,245.00 | $ 55,125.00 | $ 8,136.47 | BRSTL |
| 00110 | CLEARING AND GRUBBING | LS | $ 2,000.00 | $ 170,000.00 | $ 74,198.55 | BRSTL |
| 00120 | REGULAR EXCAVATION | CY | $ 3.03 | $ 25.00 | $ 6.46 | BRSTL |
| 00124 | ROCK EXCAVATION | CY | $ 463.42 | $ 463.42 | $ 463.42 | BRSTL |
| 00125 | GRADING | LS | $ 6,510.00 | $ 480,475.00 | $ 76,685.65 | BRSTL |
| 00140 | BORROW EXCAVATION | CY | $ 0.01 | $ 26.00 | $ 5.43 | BRSTL |
| 00150 | EMBANKMENT | CY | $ 50.00 | $ 50.00 | $ 50.00 | BRSTL |
| 00211 | MINOR STRUCTURE EXCAV. PIPE CULVERT | CY | $ 8.50 | $ 20.00 | $ 11.07 | BRSTL |
| 00212 | MINOR STRUCTURE EXCAV. BOX CULVERT | CY | $ 11.00 | $ 40.00 | $ 20.33 | BRSTL |
| 00270 | SELECT MATL. TY. I MIN. CBR-30 | TON | $ 11.98 | $ 18.50 | $ 13.37 | BRSTL |
| 00505 | BEDDING MATL.AGGR.NO. 25 OR 26 | TON | $ 14.35 | $ 26.94 | $ 20.22 | BRSTL |
| 00522 | CONCRETE CLASS A4 BOX CULVERT | CY | $ 425.41 | $ 875.00 | $ 468.82 | BRSTL |
| 00525 | CONCRETE CLASS A3 MISC. | CY | $ 496.99 | $ 1,500.00 | $ 725.80 | BRSTL |
| 00529 | FLOWABLE BACKFILL | CY | $ 199.97 | $ 300.00 | $ 205.53 | BRSTL |
| 00540 | REINF. STEEL | LB | $ 0.76 | $ 2.00 | $ 0.78 | BRSTL |
| 00542 | EPOXY COATED REINF. STEEL | LB | $ 2.00 | $ 2.00 | $ 2.00 | BRSTL |
| 00560 | STRUCTURAL STEEL JB-1 | LB | $ 25.00 | $ 25.00 | $ 25.00 | BRSTL |
| 00574 | ENDWALL GRATE & FRAME EW-11A | EA | $ 3,500.00 | $ 3,500.00 | $ 3,500.00 | BRSTL |
| 00590 | COMB. UNDERDRAIN CD-1 | LF | $ 10.00 | $ 15.00 | $ 13.00 | BRSTL |
| 00591 | COMB. UNDERDRAIN CD-2 | LF | $ 43.35 | $ 43.35 | $ 43.35 | BRSTL |
| 00595 | OUTLET PIPE | LF | $ 10.00 | $ 20.50 | $ 11.24 | BRSTL |
| 00596 | ENDWALL EW-12 | EA | $ 350.00 | $ 461.24 | $ 387.47 | BRSTL |
| 01062 | 6" CONC. PIPE | LF | $ 30.00 | $ 30.00 | $ 30.00 | BRSTL |
| 01080 | 8" PIPE | LF | $ 15.08 | $ 15.08 | $ 15.08 | BRSTL |
| 01120 | 12" PIPE | LF | $ 40.95 | $ 40.95 | $ 40.95 | BRSTL |
| 01122 | 12" CONC. PIPE | LF | $ 50.00 | $ 50.00 | $ 50.00 | BRSTL |
| 01150 | 15" PIPE | LF | $ 15.23 | $ 30.00 | $ 22.41 | BRSTL |
| 01180 | 18" PIPE | LF | $ 18.25 | $ 45.00 | $ 26.46 | BRSTL |
| 01182 | 18" CONC. PIPE | LF | $ 23.50 | $ 60.56 | $ 40.62 | BRSTL |

**Figure 28. VDOT District Averages. (VDOT 2008c)**

Applying Unit Cost Information

VDOT considers various factors for adjusting the unit prices generated from the PES when performing rational cost estimation. The following are common factors considered when adjusting unit prices, though these might vary based on work involved and specific contract provisions:

- Plan and proposal review
- Project site conditions
- Time limit
- Sequence of construction
- Seasonal limitations
- Regional conditions
- Current market conditions
- Quantities/price relationships
- Inflation and risks involved in the project

In performing the rational estimation, VDOT adjusts unit prices for the above factors based on recent bid history received for particular items of work. The labor rates available from the VEC are escalated at the average rate for the previous two years since these rates are a year old when they are published. This adjustment is applied twice to the published rate, first to bring this rate current and the second to project the cost on future work being performed. Furthermore, this rate is increased by 50 percent to 52 percent to reflect the labor burden. VDOT uses RS Means as guidance on the production rates but relies more on experience and on software like the Site Manager and BIDDS

for finding the production rates for various items of work. Site Manager reflects the current production rates from various ongoing projects in VDOT and BIDDS maintains a historical database of production rates. BIDDS is generally used within VDOT for preparing an estimate on the contract time at the pre-advertisement level, but it is also used to report historical bid item level performance data, which can be used by the estimator to estimate the production rates for individual bid items. Figure 29 shows the role of BIDDS in determining the production rates.

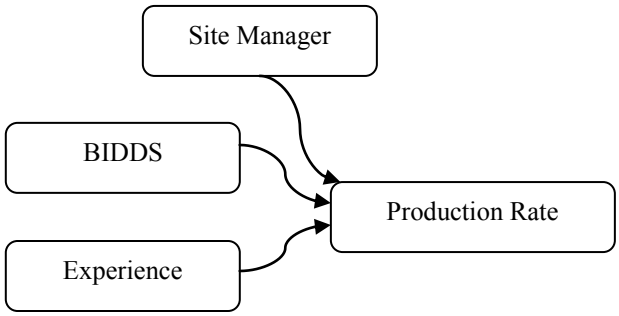



**Figure 29. VDOT Production Rate Estimation.**

VDOT uses 24 months of historical data when establishing the unit prices for its major items of work. A work item is considered a major work if it constitutes 60 percent of total estimated contract cost or 10 percent of total quantities, whichever is smaller. If sufficient historical data are available, VDOT conducts a regression analysis to establish the unit price. Otherwise, a weighted average is used for determining the unit price. VDOT performs a manual comparison of historical bid data generated by PES with recent bids and adjusts unit costs accordingly. The unit price prepared for non-standard

work item by the design division is not modified in the final engineers estimate. Sometimes other states are referenced as a check if similar work item have been used.

**Utah Department of Transportation**

General Section

UDOT follows the historical bid-based estimating technique right from the planning phase through the PS&E phase of project development. Planning level estimates are prepared using an in-house Excel spreadsheet called Concept Cost Estimate Form. UDOT prepares estimates for the remaining phases using its in-house application called Project Development Business System (PDBS). PDBS also generates bid documents for contractors to submit bids and tracks the progress of the projects and change orders. Figure 30 depicts the estimation framework of UDOT. UDOT maintains an estimation guideline on its website (UDOT 2008a and 2008b), which provide estimators with general guidelines for developing project estimates at various phases of project development.

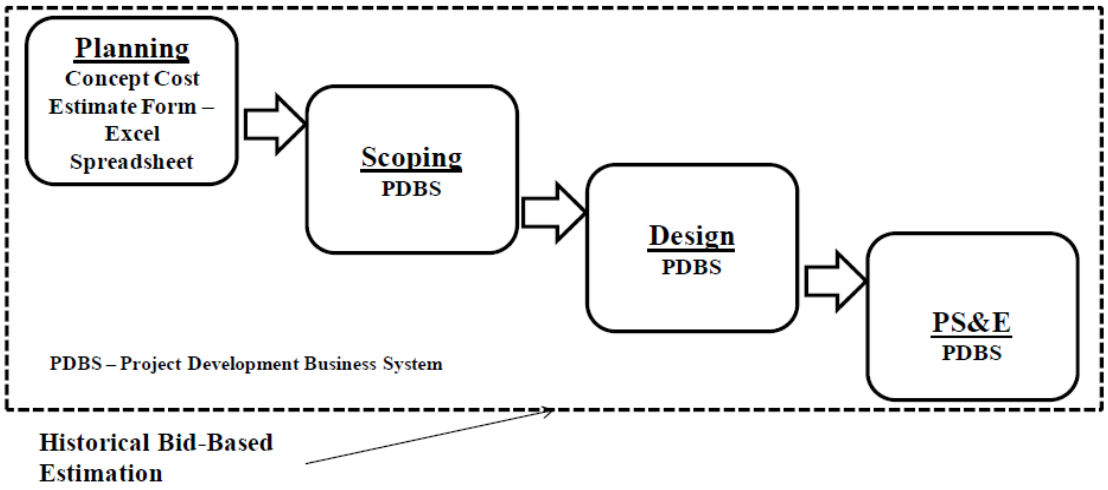



**Figure 30. UDOT Estimation Framework.**

### *Concept Cost Estimate Form*

The Cost Estimate Form developed by UDOT enables the estimators to estimate the cost involved for major items of work such as roadway and drainage, traffic and safety, structures, environmental mitigation, and Intelligent Transportation System (ITS) at the planning or conceptual level (Figure 31). Certain percentages are assumed to cover the contingency, yearly inflation, right-of-way cost, and utilities. The values for inflation, preliminary engineering, and construction engineering are not fixed and are adjusted based on engineering judgment.

**Cost Estimate - Concept Level**

| | | | | |
|---|---|---|---|---|
| Approximate Route Reference Post (BEGIN) = | 101.48 | (END) = | 106.000 | |
| Accumulated Mileage (BEGIN) = | 95.202 | (END) = | 99.872 | |
| Project Length = | 4.670 | miles | 24,658 ft | |
| Current Year = | 2007 | | | |
| Assumed Construction Year = | 2012 | | | |
| Assumed Yearly Inflation for Construction and Utility Items (%/yr) = | 7.0% | 5 yrs for inflation | | For projects 1 Year out use 10%, 2 Years 9%, 3 |
| Assumed Yearly Inflation for Engineering Services (PE and CE) (%/yr) = | 6.0% | | | |
| Assumed Yearly Inflation for Urban Residential Right of Way (%/yr) = | 6.5% | | | |
| Assumed Yearly Inflation for Urban Commercial Right of Way (%/yr) = | 4.0% | | | |
| Assumed Yearly Inflation for non-Urban Right of Way (%/yr) = | 2.0% | | | |
| Construction Items Contingency (% of Construction) = | 20.0% | | | 10% Rural PB; 15% Urban PB; 20% Non PB |
| Preliminary Engineering (% of Construction + Incentives) = | 8.0% | | | |
| Construction Engineering (% of Construction + Incentives) = | 10.0% | | | |

| Item # | | | | | Cost | Remarks |
|---|---|---|---|---|---|---|
| Construction | | | | | | |
| | Roadway and Drainage | | | | $1,502,596 | |
| | Traffic and Safety | | | | $269,450 | |
| | Structures | | | | $65,300 | |
| | Environmental Mitigation | | | | $595,000 | |
| | ITS | | | | $50,000 | |
| | | | | | | |
| | | | | Subtotal | $2,482,346 | |
| | | | Construction Items Contingency (for minor items not listed) | (20%) | $496,469 | |
| | | | | **Construction Subtotal** | **$2,978,815** | |
| P.E. Cost | | | | **P.E. Subtotal** | **$245,000** | 8% |
| C.E. Cost | | | | **C.E. Subtotal** | **$306,000** | 10% |
| Right of Way Urban/Suburban Residential | | | | **Right of Way Subtotal** | $5,000 | |
| Right of Way Urban Suburban Commercial | | | | **Right of Way Subtotal** | $15,000 | |
| Right of Way non-Urban/Suburban | | | | **Right of Way Subtotal** | $21,000 | |
| Utilities | | | | **Utilities Subtotal** | $70,500 | |
| Incentives | | | | **Incentives Subtotal** | $86,084 | |
| Miscellaneous | | | | **Miscellaneous Subtotal** | **$0** | |

| Cost Estimate (ePM screen 505) | | 2007 | | 2012 |
|---|---|---|---|---|
| Concept Report Cost | | | | |
| P.E. | | $245,000 | | $328,000 |
| Right of Way | | $41,000 | | $48,000 |
| Utilities | | $71,000 | | $100,000 |
| Construction | | $2,979,000 | | $4,178,000 |
| C.E. | | $306,000 | | $409,000 |
| Incentives | | $86,000 | | $121,000 |
| Contingency | 10% | $372,800 | | $523,000 |
| Miscellaneous | | $0 | | $0 |
| | TOTAL | $4,100,800 | TOTAL | $5,707,000 |

| | | | | |
|---|---|---|---|---|
| PROPOSED COMMISSION REQUEST | TOTAL | $4,100,800 | TOTAL | $5,707,000 |

**Figure 31. UDOT Concept Cost Estimate Form. (UDOT 2008c)**

Estimators are advised to compare the project data from PDBS and abstracts from previous projects of similar locality, size, and scope while preparing an estimate for any project. Also, the price comparison report generated using PDBS provides a quick method to evaluate the project unit prices against region or statewide averages. The price comparison report compares the average of the historical data and gives averages for each item of work (including standard deviation).

### Acquiring Unit Cost Information

UDOT utilizes its PDBS to extract all the bid details from the submitted bids.

### Storing Unit Cost Information

The database within PDBS enables UDOT to store more than five years of historical bid data in its database. The historical unit cost information is available for the entire state, districts, and counties. Historical unit costs are also available for the date range specified in PDBS, quantity range, awarded bid only, source of funding, and based on units (English or Metric). All of the historical bid details are stored as standard construction line items.

### Accessing Unit Cost Information

PDBS enables the estimator to access all the historical bid information. UDOT provides its estimators with a list of statewide average (weighted) low bid for each of the line items of work. Figure 32 shows a snapshot of the average low bid information. The low bid information is generated every year, and it is available on their website at http://www.udot.utah.gov/main/f?p=100:pg:12302720542229821131:::1:T,V:446. The

**Statewide Average Bid Price Calculation for 2007**

| Item Number | Units | Description | Unit of Measure | Average Price | Total Quantity |
|---|---|---|---|---|---|
| 00830001U | CSI - INCH/PO | Equal Opportunity Training | Hour | $4.02 | 53851 |
| 012850010 | CSI - INCH/PO | Mobilization | Lump | $221,887.12 | 115 |
| 013150010 | CSI - INCH/PO | Public Information Services | Lump | $8,684.37 | 69 |
| 015540005 | CSI - INCH/PO | Traffic Control | Lump | $116,168.75 | 106 |
| 015580005 | CSI - INCH/PO | Temporary Pavement Markings | ft | $0.10 | 16632 |
| 015710020 | CSI - INCH/PO | Check Dam (Stone) | cu yd | $81.82 | 55 |
| 015710022 | CSI - INCH/PO | Check Dam (Stone) | Each | $230.43 | 295 |
| 015710025 | CSI - INCH/PO | Check Dam (Fiber Roll) | ft | $7.16 | 5718 |
| 015710030 | CSI - INCH/PO | Silt Fence | ft | $3.37 | 85531 |
| 015710060 | CSI - INCH/PO | Drop-Inlet Barriers (Stone) | cu ft | $29.75 | 78 |
| 015710070 | CSI - INCH/PO | Drop-Inlet Barriers (Silt Fence) | ft | $8.30 | 60 |
| 015710075 | CSI - INCH/PO | Drop-Inlet Barrier (Fiber Roll) | ft | $13.00 | 3184 |
| 015710100 | CSI - INCH/PO | Curb Inlet Barrier | Each | $121.46 | 275 |
| 015710110 | CSI - INCH/PO | Pipe-Inlet Barrier (Stone) | cu yd | $158.43 | 35 |
| 015710120 | CSI - INCH/PO | Sediment Trap | cu yd | $182.19 | 30 |
| 015710130 | CSI - INCH/PO | Stabilized Construction Entrance | sq yd | $10.15 | 1238 |
| 015710140 | CSI - INCH/PO | Straw Bale Barrier | ft | $5.23 | 1664 |

**Figure 32. UDOT Statewide Average Unit Low Bid Prices. (UDOT 2008d)**

statewide average low bid price contains the average unit price, total quantity, and unit of measure for each line item of work arranged by the item number.

Applying Unit Cost Information

UDOT maintains a set of guidelines for preparing estimates during different phases of project development. The project designer is responsible for compiling and

updating the project estimates. Each design group within UDOT is required to complete the estimates for all work performed on their respective portion of a project. For example, the structural designer is required to prepare and update the estimates for structural items. PDBS tracks the history of bid items and determines the unit prices for cost estimates. The estimating chapter of UDOT's Roadway Design Manual of Instruction provides the steps that need to be followed while preparing the bid portion of Engineer's Estimate. The guidelines include the following steps:

1. Compiling quantities for each item of work and checking their accuracy against the current level of design.
2. Determining and documenting the unit prices for all items of work.
3. Assigning responsibility to each department to provide the quantities and costs for all items of work.
4. Adding necessary contingencies for unknown items, miscellaneous items, and inflation.
5. Conducting a Red Flag Analysis on the estimates.
6. Verifying the estimate is on target for project delivery and identifying areas of concerns.
7. Performing Quality Control/Quality Assurance (QC/QA).

Unit prices determined in Step 2 of the general guidelines take into consideration the following factors influencing the unit bid price:

- Location
- Time of year

- Constructability
- Quantity of item
- Limitations of operation
- Availability of materials
- Familiarity of process
- Specialty equipments
- Risk to contractors
- Construction schedule

UDOT considers seven to twelve months of historical data for establishing the unit prices using a weighted moving average for duration of one year or one quarter. Using PDBS, the estimators can also obtain the weighted unit prices based on a specified time range.

***Red Flag Analysis***

PDBS has a built in feature, Red Flag Analysis, that aides the engineers in considering factors affecting the project cost while preparing an Engineer's Estimate. The Red Flag Analysis lowers or raises the Engineer's Estimate by a certain percentage to address the specific characteristics of the project. To perform this analysis, the estimator is provided with a screen (see Figure 33) where specific questions about the project are answered.

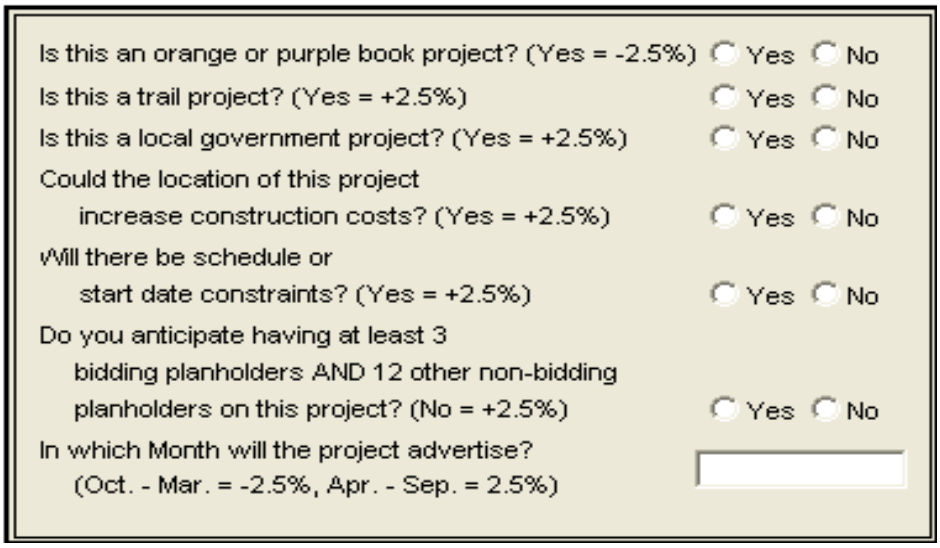



**Figure 33. UDOT Red Flag Analysis – PDBS. (UDOT 2008e)**

- **Orange/Purple Book Project**: Pavement preservation projects (Negative flag since they are simple and straightforward).
- **Trail Project**: Bike or pedestrian trail project (Positive flag since they are historically higher than estimated).
- **Local Government Project**: Historically higher than estimated due to size and increased number of project stakeholders (Positive flag if local Government project).
- **Location of Project**: Remote project locations can increase the cost of project (Positive flag if project is in a remote location).
- **Schedule/Start Date Constraints of Project**: Tight schedules without allowing any flexibility for contractor increases the project cost (Positive flag, if schedule is tight).

- **Plan holders (Contractor Interest)**: More plan holders provide more bidders leading to an increased number of bids received and lower bids. (Negative flag, if contractor interest is minimal).
- **Bidding Season**: Advertisement of project in winter leads to a negative red flag.

UDOT can also perform a Red Flag analysis on cost-sensitive materials, lump sum/specialty items, and non-bid items. Examples of cost-sensitive materials are hot mix asphalt (HMA), concrete, and steel. If the cost of these volatile materials is greater than 10 percent of the total estimate on a large project (30% for smaller project), the Red Flag Analysis suggests adding a positive flag (2.5%) to account for market volatility. Red flag analysis always suggests an increase or decrease of a constant 2.5 percent. Previous projects and experience established this value. However, the percentage can be overridden if the estimator finds it to be not appropriate for the project.

UDOT sets certain amount (percentages) for minor items of work not covered during the initial phases of project development. Table 7 includes the contingency used by UDOT to cover these minor items of work.

**Table 7. UDOT Contingency Percentages.**

| Project Phase | Contingency (%) |
|---|---|
| Planning | 25 |
| Scoping | 10 |
| Design | 10 |
| PS&E | 5 |

**California Department of Transportation**

General Section

Caltrans uses historical bid-based estimating from the Planning phase through the PS&E phase of project development. Caltrans performs cost estimation in all these phases using an in-house developed Excel spreadsheet (see Figure 34). The district offices, which are responsible for preparing the Engineer's Estimate, rely on these spreadsheets for estimation purposes. For preliminary estimates, Caltrans uses Planning Level Excel spreadsheets available on its website under the Division of Engineering Services (http://www.dot.ca.gov/hq/esc/estimates/forms). The Structures Division in Caltrans has identified cost per square unit for typical structural sections, and updates the value annually. The district offices used the value for their preliminary estimation until detailed design information is available. Figure 35 shows the comparative bridge costs developed for the year 2007 in metric units, and Figure 36 shows the Advance Planning Estimate Excel spreadsheet used by the Structures office for preparing the planning level estimates.

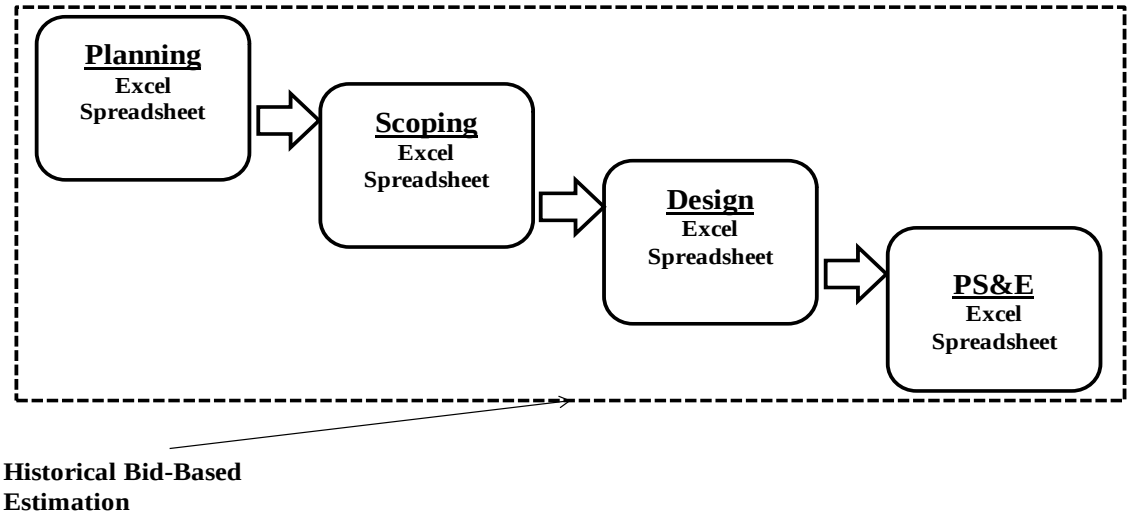



**Figure 34. Caltrans Estimation Framework.**

Factors that will increase the price over the high end of the Price Range 25%-150%

| |
|---|
| Structures with more than 2 construction stages |
| Unique substructure construction |
| Widenings less than 5 M |

| STRUCTURAL SECTION | (STR. DEPTH / MAX SPAN) SIMPLE | CONTINUOUS | COMMON SPAN RANGE meters | COST RANGE $ / Square meter | REMARKS |
|---|---|---|---|---|---|
| RC SLAB | 0.06 | 0.045 | 5 - 13 | 1700-3000 | THESE ARE THE MOST COMMON TYPES AND ACCOUNT FOR ABOUT 80% OF BRIDGES ON CALIFORNIA STATE HIGHWAYS. |
| RC T-BEAM | 0.07 | 0.065 | 12 - 18 | 1950-3200 | |
| RC BOX | 0.06 | 0.055 | 15 - 37 | 1950-3000 | |
| CIP/PS SLAB | 0.03 | 0.03 | 12 - 20 | 1850-2700 | |
| CIP/PS BOX | 0.045 | 0.04 | 30 - 76 | 1950-3000 | |
| PC/PS SLAB | 0.03 (+3" AC) | 0.03 (+3" AC) | 6 - 15 | 2250-3100 | NO FALSEWORK REQUIRED. |
| PC/PS | 0.06 (+3" AC) | 0.055 (+3" AC) | 9 - 37 | 2350-3100 | |
| BULB T GIRDER | 0.05 | 0.045 | 27 - 44 | 2350-3350 | |
| PC/PS I | 0.055 | 0.05 | 15 - 37 | 2250-3000 | |
| PC/PS BOX | 0.06 | 0.045 | 37 - 61 | 2700-4300 | |
| STRUCT STEEL I GIRDER | 0.045 | 0.04 | 18 - 91 | 2700-4100 | NO FALSEWORK REQUIRED. |

NOTE: Removal of a box girder structure costs from $160 - $215 per square meter.

**Figure 35. Comparative Bridge Costs (2007). (Caltrans 2008a)**

☐ GENERAL PLAN ESTIMATE ☐ ADVANCE PLANNING ESTIMATE

Revised - December 3, 2007

**RCVD BY:** JTY **IN EST:**

**OUT EST:**

**BRIDGE:** **BR. No.:** **DISTRICT:**

**TYPE:** **RTE:**

**CU:** **CO:**

**EA:** **KP:**

**LENGTH:** **WIDTH:** **AREA (SQ. M)=**

**DESIGN SECTION:**

**# OF STRUCTURES IN PROJECT :** **EST. NO.**

**PRICES BY :** **COST INDEX:**

**PRICES CHECKED BY :** **DATE:**

**QUANTITIES BY:** **DATE:**

| | CONTRACT ITEMS | TYPE | UNIT | QUANTITY | PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| 1 | TEMPORARY RAILING | | m | | | |
| 2 | REMOVE CONCRETE | | m3 | | | |
| 3 | STRUCTURE EXCAVATION (BRIDGE) | | m3 | | | |
| 4 | STRUCTURE EXCAVATION | | m3 | | | |
| 5 | STRUCTURE BACKFILL (BRIDGE) | | m3 | | | |
| 6 | PERVIOUS BACKFILL MATERIAL | | m3 | | | |
| 7 | CIDH CONCRETE PILING | | m | | | |
| 8 | FURNISH PILING | | m | | | |
| 9 | DRIVE PILES | | EA | | | |
| 10 | FURNISH PC/PS CONCRETE GIRDERS | | EA | | | |
| 11 | ERECT PC/PS CONCRETE GIRDERS | | EA | | | |
| 12 | STRUCTURAL CONCRETE, BRIDGE | | m3 | | | |
| 13 | STRUCTURAL CONCRETE, BRIDGE FOOTING | | m3 | | | |
| 14 | STRUCTURAL CONCRETE, APPROACH SLAB | | m3 | | | |
| 15 | PRESTRESSING STEEL | | kg | | | |
| 16 | BAR REINFORCING STEEL (BRIDGE) | | kg | | | |
| 17 | FURNISH STRUCTURAL STEEL | | kg | | | |
| 18 | ERECT STRUCTURAL STEEL (INCL PAINT) | | kg | | | |
| 19 | JOINT SEAL ASSEMBLY (MR = ) >50 mm | | m | | | |
| 20 | JOINT SEAL (MR = ) 50mm max | | m | | | |
| 21 | SLOPE PAVING | | m3 | | | |
| 22 | CONCRETE BARRIER | | m | | | |
| 23 | | | | | | |
| 24 | | | | | | |
| 25 | | | | | | |
| 26 | | | | | | |
| 27 | | | | | | |
| 28 | | | | | | |
| 29 | | | | | | |
| 30 | | | | | | |

| | |
|---|---|
| | SUBTOTAL |
| | TIME RELATED OVERHEAD |
| | MOBILIZATION ( @ 10 % ) |
| | SUBTOTAL BRIDGE ITEMS |
| | CONTINGENCIES (@ 20%) |
| | BRIDGE TOTAL COST |
| | COST PER SQ. METER |
| | BRIDGE REMOVAL (CONTINGENCIES INCL.) |
| | WORK BY RAILROAD OR UTILITY FORCES |
| | GRAND TOTAL |
| | BUDGET ESTIMATE AS OF |

**ROUTING**

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

**COMMENTS:**

**Escalated Budget Estimate to Midpoint of Construction ***

Escalation Rate per Year 5.5%

| Years Beyond Midpoint | Escalated Budget Est. |
|---|---|
| 1 | |
| 2 | |
| 3 | |

| Years Beyond Midpoint | Escalated Budget Est. |
|---|---|
| 4 | |
| 5 | |

* Escalated budget estimate is provided for information only, actual construction costs may vary. Escalated budget estimates provided do not replace Departmental policy to update cost estimates annually.

**Figure 36. Advance Planning Estimate Excel Spreadsheet. (Caltrans 2008a)**

For each item of work identified in the planning level Excel spreadsheet, the unit prices are obtained from the District 8 database containing the historical bid data and from the Highway Cost Index/Bridge Cost Index. Apart from the District 8 database, which represents statewide historical bid data, districts also rely on similar projects to compute the unit price for different items of work.

The items of work identified in the planning level spreadsheet are broken down into more detail as the project moves from planning phase through scoping and design, until the PS&E phase. The estimates are prepared for the current date and escalated to five years in the future. Caltrans has an annual update policy, which dictates an annual review of each project's estimates and an update with new escalation rates.

Acquiring Unit Cost Information

Caltrans uses their Basic Engineering Estimating System (BEES) for preparing the project design cost estimates. BEES is also used in bid opening, tracking the progress of the projects and producing segregated cost estimates based on the fund source. BEES consist of two components: (1) District (Highway) Cost Estimate and (2) the Structures (Bridge) Cost Estimate. These two components are combined to estimate the total construction cost for a project. BEES stores these two components separately and permits the recall of the combined or separate cost estimates. District Offices and the Office of Structures use the BEES coded item list for entering the District Cost Estimate and Structure Cost Estimate separately. All the associated quantities and unit prices are entered for each item of work. This forms the Preliminary Engineer's Cost Estimate (blue sheet estimate). Once the contract documents are finalized, the preliminary cost

estimate becomes the Final Engineer's Cost Estimate. Once the project is let, the bid details from all the submitted bids are stored within the BEES database.

Storing Unit Cost Information

The BEES database and the District 8 database hold the historical bid data, which is made available to all the Districts. District 8 database is updated with the recent bid details available from the BEES database. Over five years of historical data are stored and made available through the District 8 webpage (internet) as well through an Excel spreadsheet (intranet). The database holds bid data for the entire state, districts, counties, and even market areas. The Contract Item Cost Database, located in the main office, is another source for storing historical bid data though only low bid details are stored within this database.

Accessing Unit Cost Information

Estimators in various districts of Caltrans use the Contract Item Cost Database and the District 8 database (http://sv08data.dot.ca.gov/contractcost/) for accessing the historical bid data. Figure 37 presents the District 8 webpage showing the online tool developed by Caltrans for accessing historical bid data. Figure 38 provides the typical search results. Estimators can search for historical data based on such area as districts of interest, year, maximum and minimum amount, maximum and minimum quantities, and relevant unit prices.

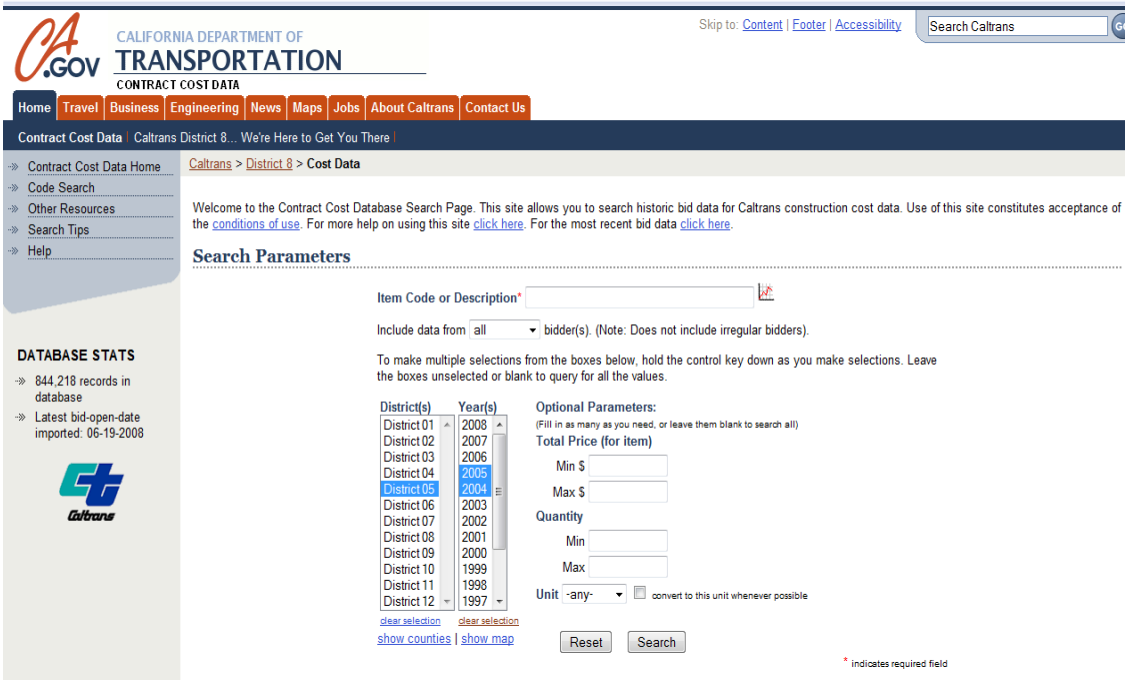



**Figure 37. Caltrans District 8 Contract Cost Database. (Caltrans 2008b)**


| | Item No. / Description | Unit | Dist | Qty | Unit Price | Adj Price | Total | Bid Open Date | Contract No. | Bid | M | TRO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $15000.00 | $13408.03 | $15000.00 | 01-07-2004 | 05-465604 | 1 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $15000.00 | $13408.03 | $15000.00 | 01-07-2004 | 05-465604 | 2 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2000.00 | $1787.74 | $2000.00 | 01-28-2004 | 05-0A1404 | 1 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2000.00 | $1787.74 | $2000.00 | 01-28-2004 | 05-0A1404 | 2 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2000.00 | $1787.74 | $2000.00 | 01-28-2004 | 05-0A1404 | 3 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2000.00 | $1787.74 | $2000.00 | 01-28-2004 | 05-0A1404 | 4 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2000.00 | $1787.74 | $2000.00 | 01-28-2004 | 05-0A1404 | 5 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $35000.00 | $31285.41 | $35000.00 | 01-28-2004 | 05-0A1404 | 6 | M | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $5950.00 | $5318.52 | $5950.00 | 02-10-2004 | 05-446904 | 1 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $6000.00 | $5363.21 | $6000.00 | 02-10-2004 | 05-446904 | 2 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $4000.00 | $3575.48 | $4000.00 | 02-10-2004 | 05-446904 | 3 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $4000.00 | $3575.48 | $4000.00 | 02-10-2004 | 05-446904 | 4 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $6000.00 | $5363.21 | $6000.00 | 02-10-2004 | 05-446904 | 5 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $6000.00 | $5363.21 | $6000.00 | 02-10-2004 | 05-446904 | 6 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $6000.00 | $5363.21 | $6000.00 | 02-10-2004 | 05-446904 | 7 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $6000.00 | $5363.21 | $6000.00 | 02-10-2004 | 05-446904 | 8 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $14900.00 | $13318.64 | $14900.00 | 02-10-2004 | 05-446904 | 9 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $1044.00 | $933.20 | $1044.00 | 03-03-2004 | 05-0C3104 | 1 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $7800.00 | $6972.18 | $7800.00 | 03-03-2004 | 05-0C3104 | 2 | | |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $2400.00 | $2145.29 | $2400.00 | 03-03-2004 | 05-0C3104 | 3 | | |

**Figure 38. Caltrans Search Results for Contract Cost Database. (Caltrans 2008b)**

The Contract Item Cost Database (Caltrans 2008c) is a tabulation of the BEES item list having weighted averages of the low bidder's prices for those items (see Figure 39).

State of California - Department of Transportation

**CONTRACT ITEM COST DATA**

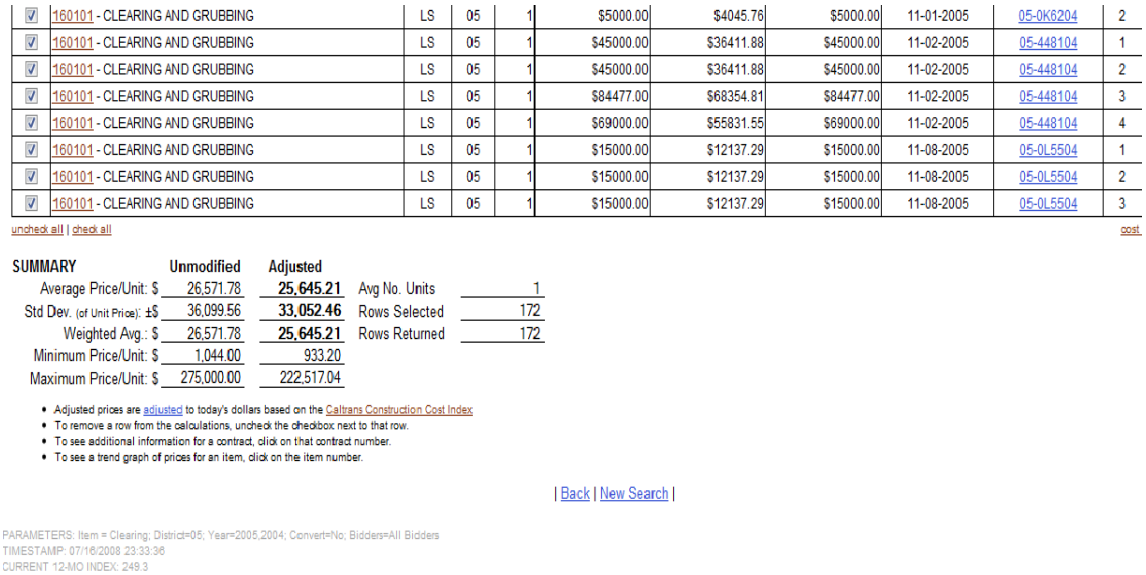
| ITEM CODE | ITEM DESCRIPTION | | UNIT | DIST | NO. OF PROJ | QUANTITY | AVE PRICE PER UNIT | TOTAL AMOUNT |
|---|---|---|---|---|---|---|---|---|
| 153103 | COLD PLANE ASPHALT CONCRETE PAVEMENT | | SQYD | 7 | 3 | 548,490.00 | $1.13 | $618,235.00 |
| | | | SQYD | 8 | 1 | 2,380.00 | $3.00 | $7,140.00 |
| | | | SQYD | 11 | 4 | 20,930.00 | $5.23 | $109,409.60 |
| | | | SQYD | 12 | 1 | 950.00 | $4.00 | $3,800.00 |
| | | **Unit Sub Total** | **SQYD** | | **32** | **1,558,264.00** | **$1.47** | **$2,289,777.40** |
| | **Item Code 153103** | **Total No. of Proj.** | | | **212** | | **Total Amount** | **$17,132,500.57** |
| 153110 | COLD PLANE ASPHALT CONCRETE PAVEMENT (.10' MAXIMUM) | | SQYD | 3 | 1 | 1,460.00 | $12.00 | $17,520.00 |
| | | **Unit Sub Total** | **SQYD** | | **1** | **1,460.00** | **$12.00** | **$17,520.00** |
| | **Item Code 153110** | **Total No. of Proj.** | | | **1** | | **Total Amount** | **$17,520.00** |
| 153152 | COLD PLANE ASPHALT CONCRETE PAVEMENT (30 MM MAXIMUM) | | M2 | 8 | 1 | 51,900.00 | $0.69 | $35,811.00 |
| | | **Unit Sub Total** | **M2** | | **1** | **51,900.00** | **$0.69** | **$35,811.00** |
| | **Item Code 153152** | **Total No. of Proj.** | | | **1** | | **Total Amount** | **$35,811.00** |
| 153153 | COLD PLANE ASPHALT CONCRETE PAVEMENT (45 MM MAXIMUM) | | M2 | 8 | 1 | 29,800.00 | $0.69 | $20,562.00 |
| | | **Unit Sub Total** | **M2** | | **1** | **29,800.00** | **$0.69** | **$20,562.00** |
| | **Item Code 153153** | **Total No. of Proj.** | | | **1** | | **Total Amount** | **$20,562.00** |

**Figure 39. Caltrans Contract Item Cost Report. (Caltrans 2008c)**

Applying Unit Cost Information

Caltrans generally uses four to six months of historical data when establishing the unit price for a line item but also considers using older data than that. The District 8 database along with the Contract Item Cost database serve as a good source of historical

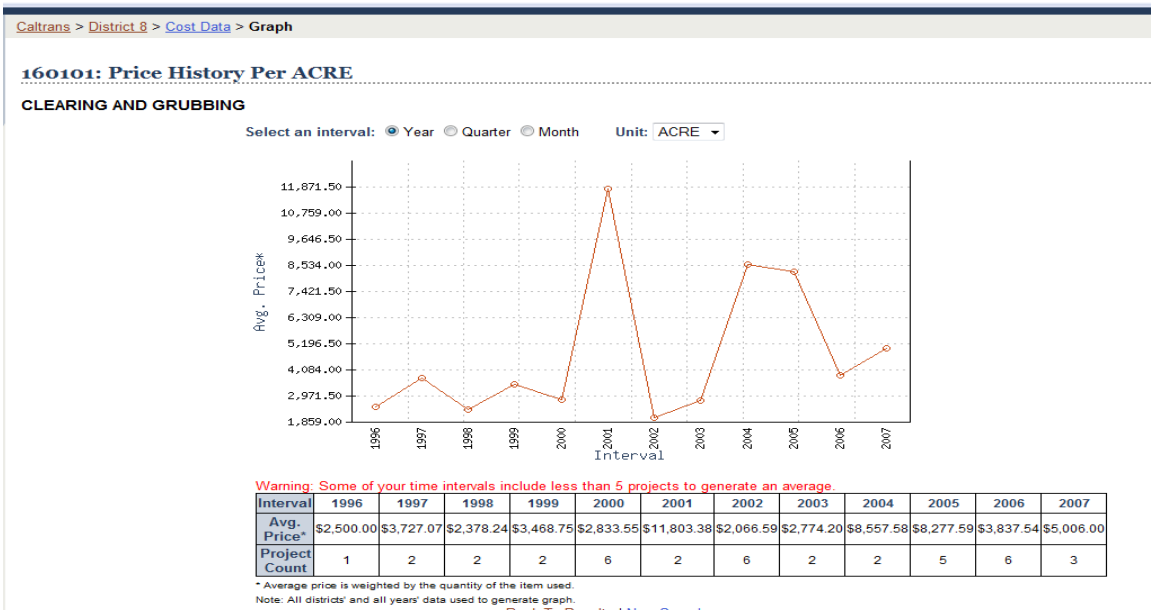
bid data for the district estimators. Based on parameters like the district number, year, minimum and maximum quantity, and minimum and maximum total price, historical bid data can be obtained for various items of work. Apart from the list of historical bid data, the database provides estimators with the simple average, weighted average (unmodified and adjusted) and standard deviation for the items selected from the search results. Figure 40 provides the summary of average price/unit along with the standard deviation. Another feature available is the generation of a trend line for the line item being searched. Figure 41 shows the trend line for line item Clearing and Grubbing. The standard deviation allows the estimators to understand the variation with the unit pricing. Though the trend analysis, shown in Figure 41, helps the estimator in modifying the unit costs, unit prices are adjusted based on experience and engineering judgment.



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $5000.00 | $4045.76 | $5000.00 | 11-01-2005 | 05-0K6204 | 2 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $45000.00 | $36411.88 | $45000.00 | 11-02-2005 | 05-448104 | 1 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $45000.00 | $36411.88 | $45000.00 | 11-02-2005 | 05-448104 | 2 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $84477.00 | $68354.81 | $84477.00 | 11-02-2005 | 05-448104 | 3 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $69000.00 | $55831.55 | $69000.00 | 11-02-2005 | 05-448104 | 4 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $15000.00 | $12137.29 | $15000.00 | 11-08-2005 | 05-0L5504 | 1 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $15000.00 | $12137.29 | $15000.00 | 11-08-2005 | 05-0L5504 | 2 |
| ☑ | 160101 - CLEARING AND GRUBBING | LS | 05 | 1 | $15000.00 | $12137.29 | $15000.00 | 11-08-2005 | 05-0L5504 | 3 |



**Figure 40. Summary of Average/Weighted Average Price. (Caltrans 2008b)**




| Interval | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Price* | $2,500.00 | $3,727.07 | $2,378.24 | $3,468.75 | $2,833.55 | $11,803.38 | $2,066.59 | $2,774.20 | $8,557.58 | $8,277.59 | $3,837.54 | $5,006.00 |
| Project Count | 1 | 2 | 2 | 2 | 6 | 2 | 6 | 2 | 2 | 5 | 6 | 3 |

**Figure 41. Trend Line Feature of Contract Cost Database. (Caltrans 2008b)**

Caltrans has standard sliding scale contingencies for different phases of project development to cover estimate uncertainties. Table 8 outlines the contingency included in Chapter 20, Project Development Cost Estimates, of Caltrans' Project Development Procedures Manual.

**Table 8. Caltrans Contingency Percentages.**

| Project Phase | Contingency (%) |
|---|---|
| Project Feasibility Cost Estimate | 30 – 50 |
| Project Study Report (PSR) Cost Estimate | 25 |
| Draft Project Report (PR) Cost Estimate | 20 |
| Project Report Cost Estimate | 15 |
| Preliminary Engineer's Cost Estimate | 10 |
| Final Engineer's Cost Estimate | 5 |

The Engineer's Estimate is checked against the low bid cost estimate received to draw a comparison between the two estimates based on the number of bidders for all projects. This would enable the estimators to analyze the effect of number of bidders on the total project cost. Figure 42 shows the comparison of the low bid with the Engineer's Estimate for all the projects let between 1993 and 2006.

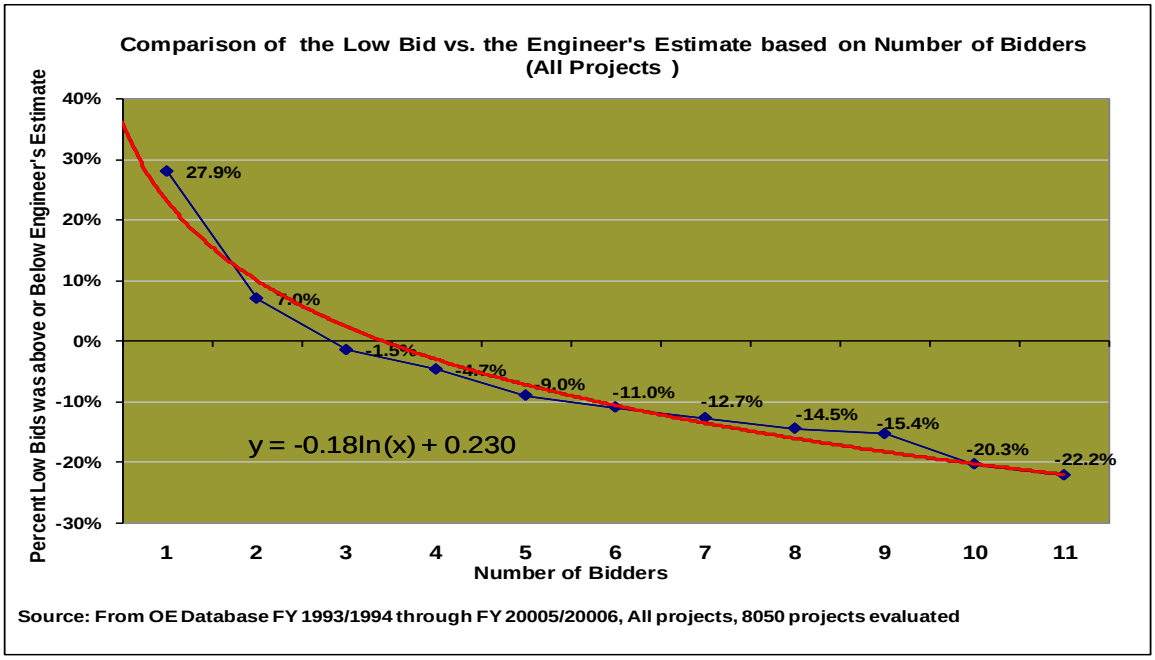



**Figure 42. Comparison of Low Bid versus Engineer's Estimate. (Caltrans 2008b)**

**Minnesota Department of Transportation**

General Section

MnDOT relies primarily on Cost-Based Estimating to prepare the Engineer's Estimate in the PS&E phase of project development. Historical bid-based estimating is used in the planning, scoping and design phase of project development. All the items of

work identified in the design phase are re-estimated in PS&E phase. MnDOT uses the CES of Trns*port system for preparing the final Engineer's Estimate. Preliminary estimates and design level estimates are prepared using Excel spreadsheets, developed in-house, at the District Offices. The source of historical unit cost is an Excel spreadsheet generated by the Trns*port system. This Excel spreadsheet is available on their intranet as well as MnDOT's website. Bridge estimates are prepared separately and added to the final estimate. Estimators use the 80/20 rule, that is, 20 percent of work contributes to 80 percent of the total cost when preparing cost estimates. Major items of work are estimated using a cost-based estimating approach, while the minor items are estimated by taking the arithmetic average of historical bid data.

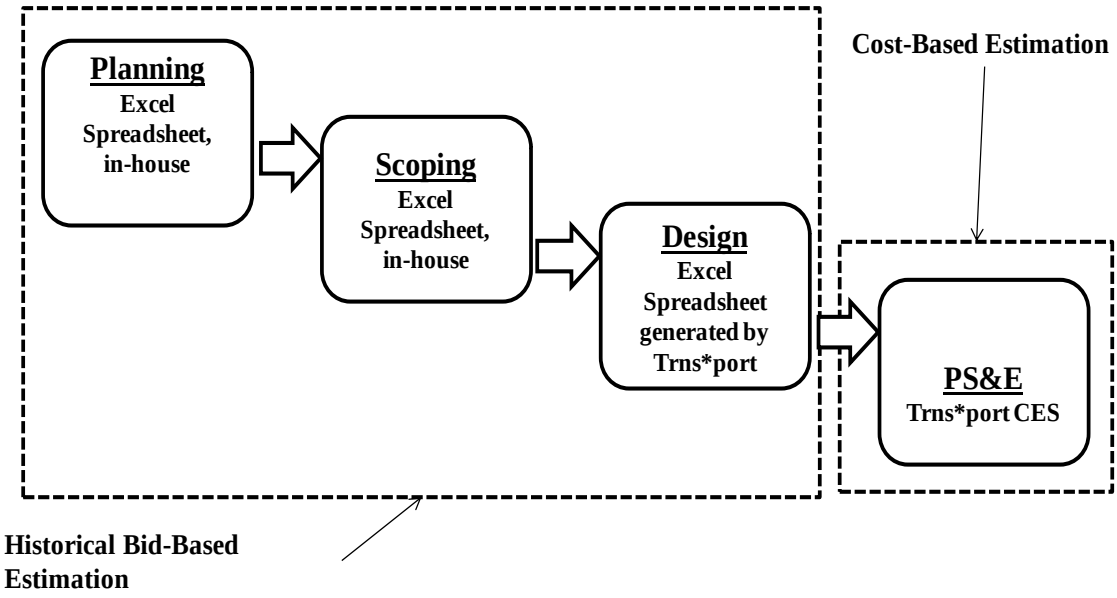



**Figure 43. MnDOT Estimation Framework.**

Acquiring Unit Cost Information

MnDOT uses different libraries or catalogs for storing the labor, materials, equipment, and production rate data in CES. A separate library containing historical data from June 2006 to June 2008 is used as source of historical bid data in CES. The estimators use historical bid data extracted from BAMS/DSS when preparing the historical cost library. Using BAMS/DSS, the threshold on the number of historical bid data used in the regression analysis and arithmetic average can be set. MnDOT uses a minimum of 15 occurrences of historical data when performing the regression analysis and a minimum of 10 occurrences when performing arithmetic average. The catalogs for labor, material, equipment, and production rates are updated every year from their respective sources given in Table 9.

**Table 9. MnDOT Source of Equipment, Labor, Material, and Production Rates.**

| | |
|---|---|
| Equipment Costs | Commissioners Equipment Rental Rates, Department of Labor Truck Rental Rates, Rental Blue Book (Vol. 3) |
| Material Costs | Call suppliers and Materials Engineers |
| Labor rates | Minnesota department of labor and industry |
| Production Rates | Contract time (Construction Division of MnDOT) |

Storing Unit Cost Information

The historical unit costs are stored in BAMS/DSS of Trns*port system. The BAMS/DSS stores over five years of historical bid data as standard construction line

items. Historical unit costs are available for the entire state, districts, and counties. District offices have historical bid data stored in Excel spreadsheets.

Accessing Unit Cost Information

MnDOT uses an Excel spreadsheet containing all the bid information available on their intranet (iHub) and their internet website. This spreadsheet is generated from BAMS/DSS and made available to all the District offices for estimation purposes. Estimators can sort historical unit costs based on Item Id, Item Description, Quantities, Districts, Engineer's Estimate, and three low bidders. Figure 44 and Figure 45 show a snapshot of the Excel spreadsheet used by the estimators at MnDOT.

| Item | Item Description | Dist. | Quarter | Contract | County | SP | Units | QTY |
|---|---|---|---|---|---|---|---|---|
| 2011601/00001 | CONSTRUCTION LAYOUT STAKING | 3 | 2003Q2 | 030050 | STEARNS | 7380-206 | LS | 1 |
| 2011601/00001 | CONSTRUCTION LAYOUT STAKING | 4 | 2003Q3 | 030165 | DOUGLAS | 2101-20 | LS | 1 |
| 2011601/00001 | CONSTRUCTION LAYOUT STAKING | 7 | 2003Q2 | 030080 | BLUE EARTH | 0703-16 | LS | 1 |
| 2011601/00001 | CONSTRUCTION LAYOUT STAKING | M | 2003Q2 | 030073 | HENNEPIN | 2723-109 | LS | 1 |
| 2011601/00001 | CONSTRUCTION LAYOUT STAKING | 2 | 2003Q2 | 030067 | BELTRAMI | 0416-31 | LS | 1 |
| 2011601/00002 | TUNNEL CONSTRUCTION LAYOUT STAKING | M | 2005Q2 | 050073 | HENNEPIN | 2771-31 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q1 | 030027 | KOOCHICHING | 3609-30 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q1 | 030054 | CARLTON | 0906-42 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q2 | 030082 | CARLTON | 0901-72 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q2 | 030125 | VARIOUS | 8821-73 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q3 | 030207 | ST LOUIS | 6920-37 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2003Q4 | 030227 | ITASCA | 3108-56 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2004Q2 | 040008 | ITASCA | 3108-63 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2004Q2 | 040083 | LAKE | 3805-90 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2004Q2 | 040128 | KOOCHICHING | 8821-74 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2004Q3 | 040161 | ST LOUIS | 6903-13 | LS | 1 |
| 2011601/00003 | CONSTRUCTION SURVEYING | 1 | 2004Q3 | 040162 | ST LOUIS | 6928-26 | LS | 1 |

**Figure 44. MnDOT Historical Price Database. (MnDOT 2008)**

| Awarded Price | Second Bidder | Third Bidder | Estimate |
|---|---|---|---|
| $84,900.00 | $84,900.00 | $96,000.00 | $44,800.00 |
| $10,000.00 | $13,900.00 | $15,000.00 | $20,000.00 |
| $20,000.00 | $10,000.00 | $40,000.00 | $22,000.00 |
| $66,000.00 | $60,000.00 | $11,800.00 | $48,200.00 |
| $40,000.00 | $42,000.00 | $41,200.00 | $70,800.00 |
| $67,000.00 | $15,000.00 | $67,000.00 | $8,000.00 |
| $18,700.00 | $14,000.00 | $15,368.82 | $17,600.00 |
| $83,000.00 | $118,000.00 | $95,000.00 | $40,000.00 |
| $30,837.00 | $30,857.00 | $31,600.00 | $40,000.00 |
| $9,500.00 | $15,000.00 | $13,300.00 | $26,400.00 |
| $275,000.00 | $201,840.00 | $233,000.00 | $125,000.00 |
| $105,000.00 | $140,000.00 | $108,500.00 | $85,000.00 |
| $50,204.00 | $76,000.00 | $85,000.00 | $85,000.00 |
| $10,000.00 | $15,000.00 | $12,000.00 | $15,000.00 |
| $16,520.00 | $15,863.10 | $7,595.25 | $4,769.60 |
| $30,000.00 | $50,000.00 | $0.00 | $17,520.00 |
| $65,000.00 | $68,000.00 | $61,000.00 | $10,700.00 |

**Figure 45. MnDOT Historical Price Database. (MnDOT 2008)**

Estimators at MnDOT also make use of project abstracts when preparing all types of estimates. Project abstracts (MnDOT 2008b) provides the bid tabulation details based on the year selected. The abstracts are available for every month in the year selected, and they enable the estimators to consider unit prices used by the contractors in past projects. Figure 46 shows the abstract for a project let in January 2007.

LETTING : 07012601 CALL : 013 COUNTIES : HENNE

LETTING DATE : 01/26/07 9:30 A.M.
JOB NO. : 070013 DISTRICT : M
STATE PROJECT : 2789-126 ROUTE : TH 394=010 LENGTH :
CONTRACT NO. : S07013 START DATE: 07/30/07 COMPLETION DATE

| LINE NO / ITEM CODE / ALT ITEM DESCRIPTION | QUANTITY | | ( 0 ) -EST- ENGINEER'S ESTIMATE UNIT PRICE | AMOUNT | ( 1 ) E110 EGAN COMPANIES UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| 0030 2104509/00150 REMOVE FOUNDATION | 2.000 | EACH | 200.00000 | 400.00 | 650.00000 | 1300.00 |
| 0040 2104509/00290 REMOVE SERVICE INSTALLATION | 1.000 | EACH | 250.00000 | 250.00 | 475.00000 | 475.00 |
| 0050 2104509/00300 REMOVE SERVICE EQUIPMENT | 1.000 | EACH | 400.00000 | 400.00 | 335.00000 | 335.00 |
| 0060 2104509/00399 REMOVE HANDHOLE | 5.000 | EACH | 225.00000 | 1125.00 | 250.00000 | 1250.00 |
| 0070 2104601/00085 REMOVE MISCELLANEOUS STRUCTURES | | LUMP | 10000.00000 | 10000.00 | 2800.00000 | 2800.00 |
| 0080 2211501/00050 AGGREGATE BASE CLASS 5 | 50.000 | TON | 21.32000 | 1066.00 | 36.00000 | 1800.00 |
| 0090 2550511/00010 PEDESTAL FOUNDATION | 1.000 | EACH | 600.00000 | 600.00 | 500.00000 | 500.00 |
| 0100 2550511/00020 CABINET FOUNDATION | 1.000 | EACH | 2000.00000 | 2000.00 | 2050.00000 | 2050.00 |
| 0110 2550511/00031 SERVICE FOUNDATION | 2.000 | EACH | 1400.00000 | 2800.00 | 1150.00000 | 2300.00 |
| 0120 2550511/00048 SHELTER FOUNDATION | 1.000 | EACH | 4500.00000 | 4500.00 | 12780.00000 | 12780.00 |
| 0130 2550512/00041 HANDHOLE TYPE-PVC METAL COVER | 4.000 | EACH | 775.00000 | 3100.00 | 885.00000 | 3540.00 |
| 0140 2550514/00010 FIBEROPTIC SPLICE VAULT | 3.000 | EACH | 3814.59000 | 11443.77 | 4785.00000 | 14355.00 |
| 0150 2550515/00010 OUTDOOR FIBER SPLICE ENCLOSURE | 6.000 | EACH | 1500.00000 | 9000.00 | 1625.00000 | 9750.00 |
| 0160 2550516/00010 BURIED CABLE SIGN | 12.000 | EACH | 100.00000 | 1200.00 | 105.00000 | 1260.00 |

**Figure 46. MnDOT Project Abstracts. (MnDOT 2008)**

Applying Unit Cost Information

MnDOT generally considers using seven to twelve months of historical data for establishing the unit prices. Labor rates, material rates, and equipment rates are periodically tracked and updated annually. Only the labor and the material rates are adjusted based on project location. According to MnDOT Standard Specification 1904 (http://www.dot.state.mn.us/tecsup/spec/2005/1100-1911.pdf), overhead, and profit are assumed as follows for all the estimates:

- Labor – 62% of taxable wages + fringes
- Equipment – 0%
- Material – 15%

- Subcontractor – 10%

Major items of work are estimated using the cost-based estimation technique while the minor items of work are estimated by taking the arithmetic average or by regression analysis of historical bid data when preparing the Engineer's Estimate. Production rates for each task are calculated based on labor and equipment rates, material costs, and quantity. Adjustments to unit prices are primarily based on experience and engineering judgment, although haul distance factors are used for equipment pricing adjustments.

**New York State Department of Transportation**

General Section

NYSDOT's main estimating technique is historical bid-based estimating, which they use to prepare estimates in the Design and PS&E phase of project development (see Figure 47). NYSDOT uses the Trns*port suite of software extensively for project development and construction management. Trns*port Estimator is used to prepare the design level estimate as well as the Engineer's Estimate at the end of the PS&E phase. NYSDOT also uses the Tracer software for preliminary cost estimation since it offers the flexibility to add many special requirements, typical of NYSDOT. Estimators also use the Preliminary Cost Estimation spreadsheet (see Figure 48) available for bridges to prepare early bridge estimates. This spreadsheet is available on NYSDOT's Office of Structures webpage and is used to estimate the bridge cost for new and replacement bridge projects. The Preliminary Cost Estimation spreadsheet is based on Bridge

Shoulder Break Area methodology (see Figure 49) developed by NYSDOT and used early in the project when bridge particulars like the site location and abutment heights are not known. The costs are taken from Weighted Average Item Price Report (WAIPR) or their 2005/2006 Bridge Features Cost Estimate Summary report available under the Engineering Section of their Office of Structures webpage (https://www.nysdot.gov/portal/page/portal/divisions/engineering/structures/manuals/preliminary-cost). Estimates are then validated against the current or recently completed projects of similar scope.

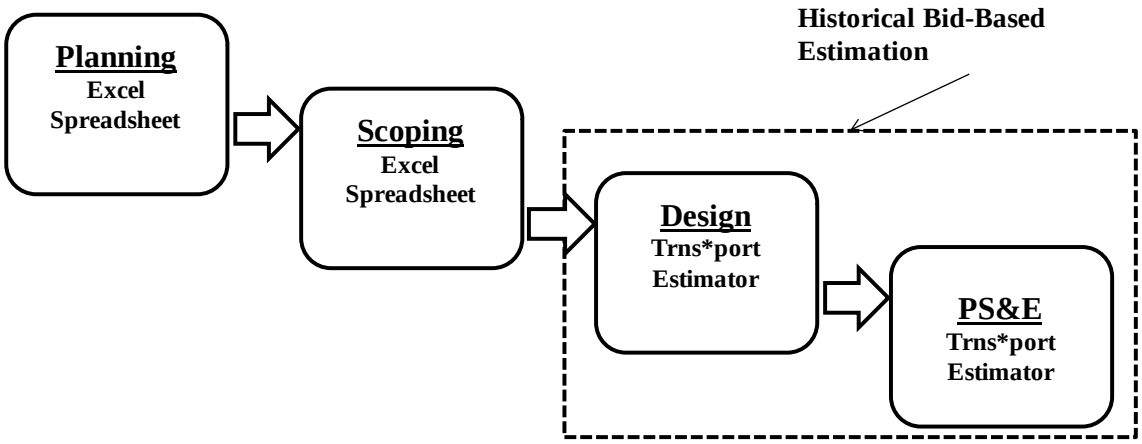
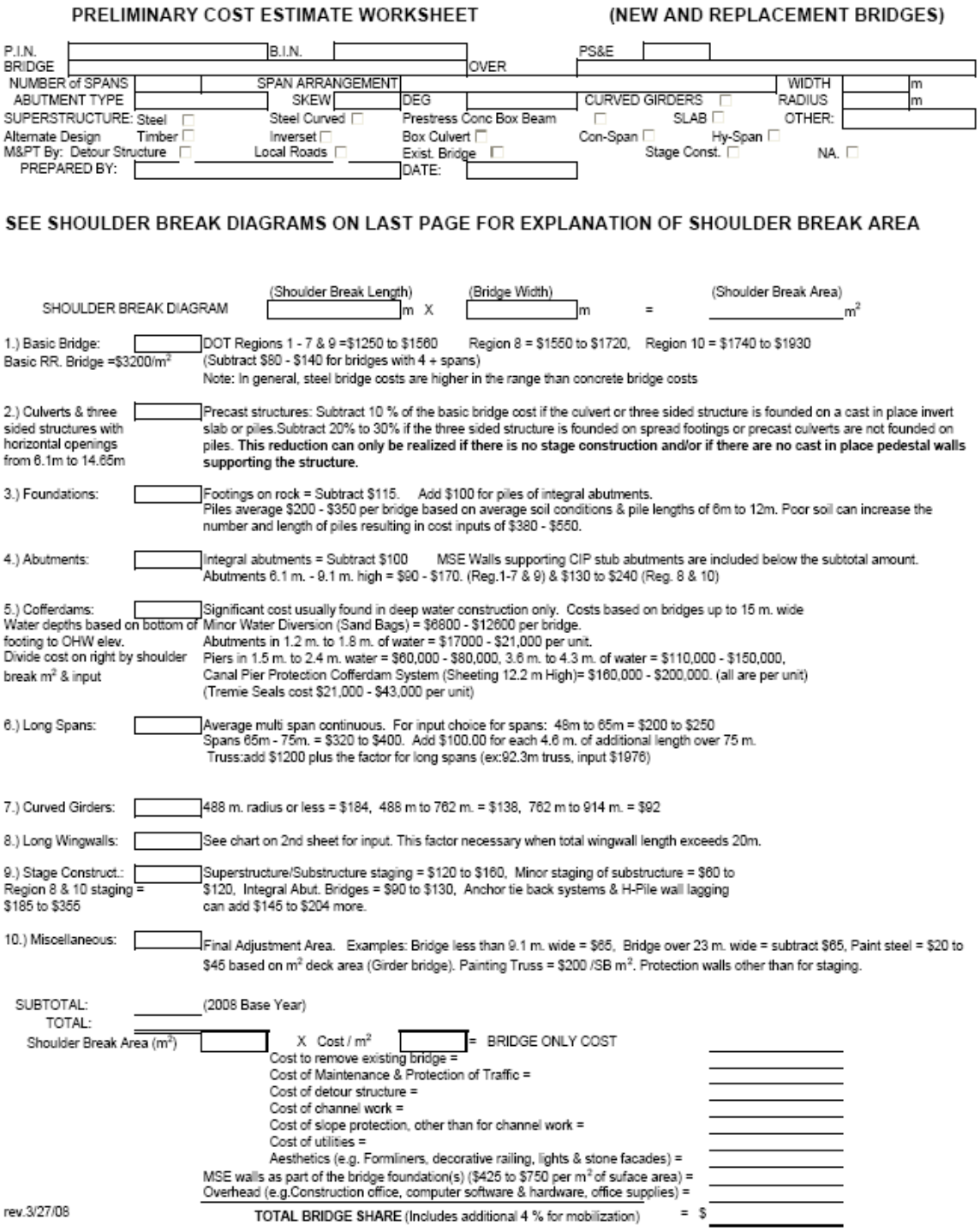



**Figure 47. NYSDOT Estimation Framework.**



PRELIMINARY COST ESTIMATE WORKSHEET (NEW AND REPLACEMENT BRIDGES)

P.I.N. B.I.N. PS&E
BRIDGE OVER
NUMBER of SPANS SPAN ARRANGEMENT WIDTH m
ABUTMENT TYPE SKEW DEG CURVED GIRDERS RADIUS m
SUPERSTRUCTURE: Steel Steel Curved Prestress Conc Box Beam SLAB OTHER:
Alternate Design Timber Inverset Box Culvert Con-Span Hy-Span
M&PT By: Detour Structure Local Roads Exist. Bridge Stage Const. NA.
PREPARED BY: DATE:

SEE SHOULDER BREAK DIAGRAMS ON LAST PAGE FOR EXPLANATION OF SHOULDER BREAK AREA

SHOULDER BREAK DIAGRAM (Shoulder Break Length) m X (Bridge Width) m = (Shoulder Break Area) $m^2$

1.) Basic Bridge: DOT Regions 1 - 7 & 9 =$1250 to $1560 Region 8 = $1550 to $1720, Region 10 = $1740 to $1930
Basic RR. Bridge =$3200/$m^2$ (Subtract $80 - $140 for bridges with 4 + spans)
Note: In general, steel bridge costs are higher in the range than concrete bridge costs

2.) Culverts & three sided structures with horizontal openings from 6.1m to 14.65m: Precast structures: Subtract 10 % of the basic bridge cost if the culvert or three sided structure is founded on a cast in place invert slab or piles.Subtract 20% to 30% if the three sided structure is founded on spread footings or precast culverts are not founded on piles. **This reduction can only be realized if there is no stage construction and/or if there are no cast in place pedestal walls supporting the structure.**

3.) Foundations: Footings on rock = Subtract $115. Add $100 for piles of integral abutments.
Piles average $200 - $350 per bridge based on average soil conditions & pile lengths of 6m to 12m. Poor soil can increase the number and length of piles resulting in cost inputs of $380 - $550.

4.) Abutments: Integral abutments = Subtract $100 MSE Walls supporting CIP stub abutments are included below the subtotal amount.
Abutments 6.1 m. - 9.1 m. high = $90 - $170. (Reg.1-7 & 9) & $130 to $240 (Reg. 8 & 10)

5.) Cofferdams: Water depths based on bottom of footing to OHW elev. Divide cost on right by shoulder break $m^2$ & input: Significant cost usually found in deep water construction only. Costs based on bridges up to 15 m. wide
Minor Water Diversion (Sand Bags) = $6800 - $12600 per bridge.
Abutments in 1.2 m. to 1.8 m. of water = $17000 - $21,000 per unit.
Piers in 1.5 m. to 2.4 m. water = $60,000 - $80,000, 3.6 m. to 4.3 m. of water = $110,000 - $150,000,
Canal Pier Protection Cofferdam System (Sheeting 12.2 m High)= $160,000 - $200,000. (all are per unit)
(Tremie Seals cost $21,000 - $43,000 per unit)

6.) Long Spans: Average multi span continuous. For input choice for spans: 48m to 65m = $200 to $250
Spans 65m - 75m. = $320 to $400. Add $100.00 for each 4.6 m. of additional length over 75 m.
Truss:add $1200 plus the factor for long spans (ex:92.3m truss, input $1976)

7.) Curved Girders: 488 m. radius or less = $184, 488 m to 762 m. = $138, 762 m to 914 m. = $92

8.) Long Wingwalls: See chart on 2nd sheet for input. This factor necessary when total wingwall length exceeds 20m.

9.) Stage Construct.: Region 8 & 10 staging = $185 to $356: Superstructure/Substructure staging = $120 to $160, Minor staging of substructure = $60 to $120, Integral Abut. Bridges = $90 to $130, Anchor tie back systems & H-Pile wall lagging can add $145 to $204 more.

10.) Miscellaneous: Final Adjustment Area. Examples: Bridge less than 9.1 m. wide = $65, Bridge over 23 m. wide = subtract $65, Paint steel = $20 to $45 based on $m^2$ deck area (Girder bridge). Painting Truss = $200 /SB $m^2$. Protection walls other than for staging.

SUBTOTAL: (2008 Base Year)
TOTAL:
Shoulder Break Area ($m^2$) X Cost / $m^2$ = BRIDGE ONLY COST
Cost to remove existing bridge =
Cost of Maintenance & Protection of Traffic =
Cost of detour structure =
Cost of channel work =
Cost of slope protection, other than for channel work =
Cost of utilities =
Aesthetics (e.g. Formliners, decorative railing, lights & stone facades) =
MSE walls as part of the bridge foundation(s) ($425 to $750 per $m^2$ of suface area) =
Overhead (e.g.Construction office, computer software & hardware, office supplies) =
rev.3/27/08 **TOTAL BRIDGE SHARE** (Includes additional 4 % for mobilization) = $

**Figure 48. NYSDOT Preliminary Cost Estimate Worksheet for New and Replacement Bridges. (NYSDOT 2008b)**

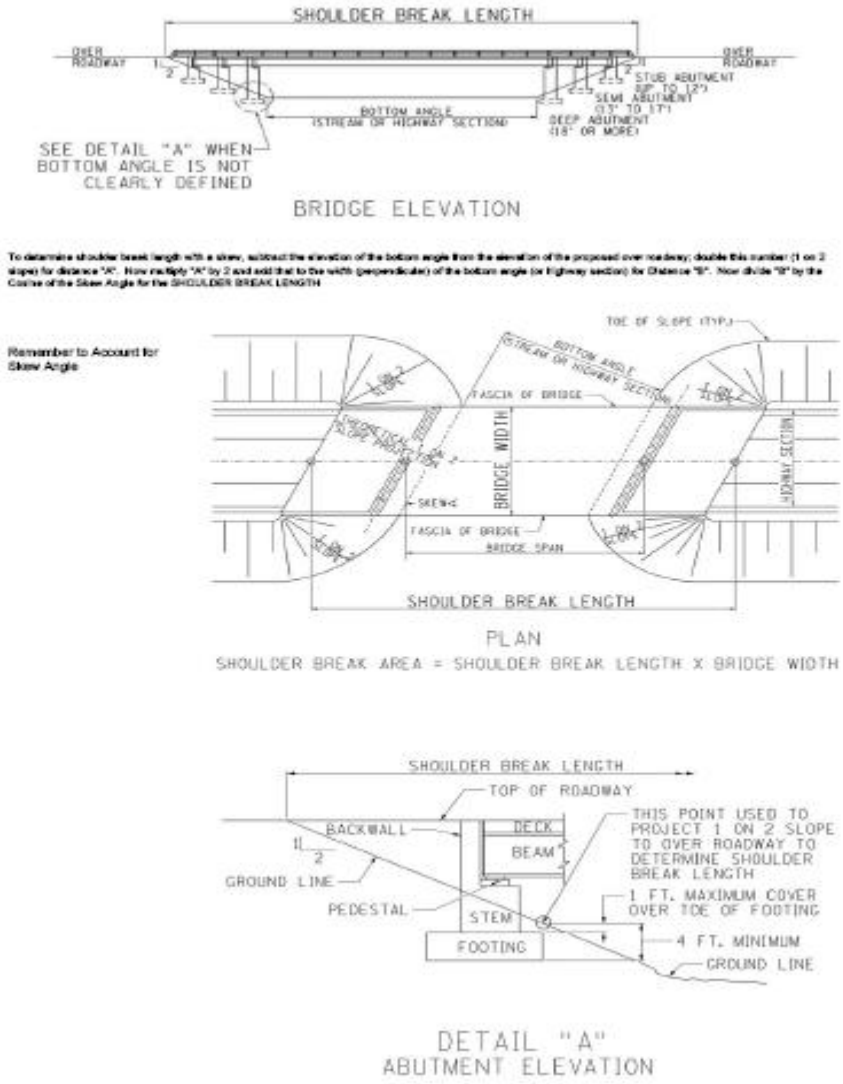



**Figure 49. Shoulder Break Area Diagram – NYSDOT Preliminary Cost Estimate Worksheet. (NYSDOT 2008b)**

Acquiring Unit Cost Information

Historical unit costs are acquired from the submitted bids by the contractors through the Letting and Approval System (LAS) and Site Manager of Trns*port suite of

software. The BAMS/DSS stores the historical unit prices from the three lowest bids. Figure 50 explains the flow of historical bid data within the Trns*port system.

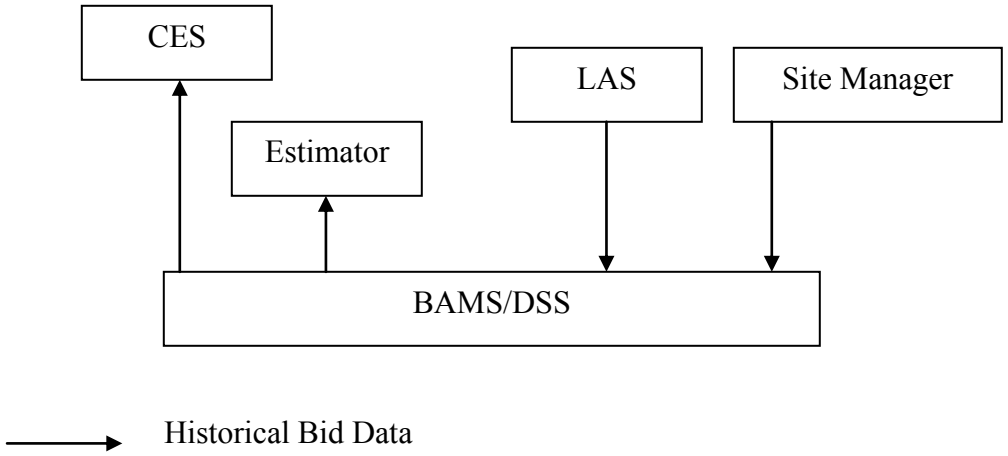



**Figure 50. NYSDOT Historical Unit Costs within Trns*port System.**

Storing Unit Cost Information

The historical bid prices stored in the BAMS/DSS database of the Trns*port system consist of the three lowest historical bid made available from the LAS and Site Manager. The BAMS/DSS database for NYSDOT consists of historical bid data available over a period of five years.

Accessing Unit Cost Information

NYSDOT unit cost information can be accessed through the Weighted Average Item Price Report (WAIPR) and the Regional and Statewide Average Awarded Price Report (RSWAAPR) available on their website (http://www.nysdot.gov). WAIPR (see Figure 51) is generated using the Trns*port system and RSWAAPR (see Figure 52) is

generated using the Crystal Reports® software. Both of the reports contain all the items let during the period indicated in the report. WAIPR and RSWAAPR are generated twice a year containing the total dollars and weighted average price of the three low bidders. NYSDOT updates their historical bid prices every quarter.

New York State Department of Transportation 10:40 Wednesday, March 26, 2008
Contracts Let January 1, 2007 to December 31, 2007

WEIGHTED AVERAGE ITEM PRICE REPORT
BY ITEM, REGION AND QUARTER

| ITEM | REGION | CALENDAR QUARTER | NUMBER OF OCCUR'S | TOTAL QUANTITY | TOTAL DOLLARS | AVERAGE AWARDED PRICE | AVERAGE OF LOW 3 BIDDERS |
|---|---|---|---|---|---|---|---|
| REMOVAL OF SUBSTRUCTURES / CM | | | | | | | |
| 202.19 | 04 | 2007Q1 | 3 | 398.00 | $21,500 | $54.02 | $73.07 |
| | | 2007Q2 | 2 | 211.00 | $20,375 | $96.56 | $87.36 |
| | | 2007Q3 | 2 | 1,725.00 | $85,925 | $49.81 | $63.13 |
| | 05 | 2007Q2 | 2 | 2,645.00 | $100,050 | $37.83 | $39.23 |
| | | 2007Q3 | 1 | 206.00 | $14,420 | $70.00 | $80.00 |
| | | 2007Q4 | 1 | 4,650.00 | $116,250 | $25.00 | $35.00 |
| | 06 | 2007Q1 | 1 | 598.00 | $53,820 | $90.00 | $103.33 |
| | | 2007Q2 | 5 | 978.00 | $88,790 | $90.79 | $89.19 |
| | 07 | 2007Q1 | 1 | 406.00 | $38,570 | $95.00 | $105.45 |
| | | 2007Q2 | 1 | 354.00 | $30,090 | $85.00 | $85.00 |
| | | 2007Q3 | 1 | 62.00 | $3,720 | $60.00 | $85.47 |
| | 08 | 2007Q1 | 2 | 2,936.00 | $293,600 | $100.00 | $131.63 |
| | | 2007Q3 | 1 | 366.00 | $36,600 | $100.00 | $225.00 |
| | 09 | 2007Q2 | 1 | 374.00 | $22,440 | $60.00 | $92.00 |
| | 10 | 2007Q1 | 1 | 453.00 | $113,250 | $250.00 | $340.00 |
| | | 2007Q3 | 1 | 2,021.00 | $3,536,750 | $1,750.00 | $1,333.33 |
| | 11 | 2007Q1 | 2 | 1,099.00 | $276,280 | $251.39 | $420.46 |
| | | | 39 | 23,749.00 | $5,255,833 | $221.31 | $203.87 |

**Figure 51. NYSDOT Weighted Average Item Price Report (WAIPR) - January 2007 to December 2007. (NYSDOT 2008a)**

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
REGIONAL AND STATEWIDE WEIGHTED AVERAGE AWARDED PRICES
CONTRACTS LET JANUARY 1, 2007 TO DECEMBER 31, 2007

| ITEM | DESCRIPTION | REGION | UNITS | # OF OCCUR'S | TOTAL QUANTITY | AVG. AWARDED PRICE |
|---|---|---|---|---|---|---|
| 201.07 | CLEARING AND GRUBBING | | HA | | | |
| | | 03 | | 1 | 2.0 | $74,500.00 |
| | | 06 | | 1 | 40.9 | $4,500.00 |
| | | 09 | | 1 | 1.0 | $1.00 |
| | | 11 | | 1 | 2.0 | $15,000.00 |
| | | STATEWIDE | | 4 | 45.9 | $7,907.38 |
| 201.0701 63 | CLEAR GRUBBING, EM/STBY, R 1 (0 -0.2) | | HA | | | |
| | | 01 | | 2 | 2.0 | $1,750.00 |
| | | STATEWIDE | | 2 | 2.0 | $1,750.00 |
| 201.0702 63 | CLEAR GRUBBING, EM/STBY, R 2 (0.2 - 0.4) | | HA | | | |
| | | 01 | | 2 | 2.0 | $750.00 |
| | | STATEWIDE | | 2 | 2.0 | $750.00 |
| 201.0703 63 | CLEAR GRUBBING, EM/STBY, R 3 (0.4 - 0.2) | | HA | | | |
| | | 01 | | 2 | 2.0 | $750.00 |
| | | STATEWIDE | | 2 | 2.0 | $750.00 |
| 202.0501 | REM/DISP OF PETRO STOR TANK(0-1050)LITER | | EACH | | | |
| | | 05 | | 1 | 8.0 | $1.00 |
| | | 10 | | 1 | 4.0 | $1,000.00 |
| | | STATEWIDE | | 2 | 12.0 | $334.00 |
| 202.0502 | DISP PETRO STOR TANKS (1051-1900)LITERS | | EACH | | | |
| | | 04 | | 1 | 1.0 | $1.00 |
| | | STATEWIDE | | 1 | 1.0 | $1.00 |
| 202.0503 | DISP OF PETRO STOR TANK(1901-3800)LITERS | | EACH | | | |
| | | 03 | | 1 | 2.0 | $1,600.00 |
| | | 06 | | 1 | 1.0 | $2,500.00 |
| | | STATEWIDE | | 2 | 3.0 | $1,900.00 |
| 202.0504 | DISP -PETRO STOR TANK(3801-9500)LITERS | | EACH | | | |
| | | 03 | | 1 | 3.0 | $4,800.00 |
| | | 10 | | 1 | 2.0 | $2,450.00 |
| | | STATEWIDE | | 2 | 5.0 | $3,860.00 |
| 202.17 04 | CHEM OXYGENAT MAT IN-SITU REMEDIATION | | KG | | | |
| | | 04 | | 1 | 3,468.0 | $7.95 |
| | | STATEWIDE | | 1 | 3,468.0 | $7.95 |
| 202.19 | REMOVAL OF SUBSTRUCTURES | | CM | | | |
| | | 01 | | 4 | 460.0 | $129.46 |
| | | 02 | | 5 | 2,527.0 | $101.96 |
| | | 03 | | 2 | 1,280.0 | $67.34 |
| | | 04 | | 7 | 2,334.0 | $54.76 |
| | | 05 | | 4 | 7,501.0 | $30.76 |
| | | 06 | | 6 | 1,576.0 | $90.49 |
| | | 07 | | 3 | 822.0 | $88.05 |
| | | 08 | | 3 | 3,302.0 | $100.00 |
| | | 09 | | 1 | 374.0 | $60.00 |
| | | 10 | | 2 | 2,474.0 | $1,475.34 |
| | | 11 | | 2 | 1,099.0 | $251.39 |
| | | STATEWIDE | | 39 | 23,749.0 | $221.31 |

**Figure 52. NYSDOT Regional and Statewide Average Award Prices (RSWAAPR) - January 2007 to December 2007. (NYSDOT 2008a)**

BAMS/DSS data are used in generating the RSWAAPR report through the Crystal Reports Software. This reporting tool is much faster and works directly with the historical bid data in the BAMS database to generate customized reports. The data

obtained through this tool can be saved to an Excel spreadsheet for further statistical analysis in Excel. NYSDOT also uses Crystal Reports software to prepare graphical reports on the accuracy of Engineer's Estimate. This software also allows grouping of historical bid data based on the different work types such as grading/excavation, pavements and traffic control.

Applying Unit Cost Information

NYSDOT considers seven to twelve months of historical data for establishing unit prices through bid-based estimation and the use of WAIPR and RSWAAPR for the necessary weighted average of historical prices. Scatter plots are also used in determining the unit prices. The unit prices are then adjusted based on the quantities used in the project—the higher the quantity, the lower the unit price and vice versa. Adjustment of unit prices for project type and complexity is based on engineering judgment and experience. NYSDOT, as per Federal Highway Administration (FHWA) guidance on estimating, performs either historical bid-based estimating or cost-based estimating or a combination of both. Major items of work, which contribute significantly to the total project cost, are once again estimated using cost-based estimating approach. NYSDOT applies certain percentages for contingency during different phases of project development. Table 10 provides contingency ranges recommended by NYSDOT for its projects.

**Table 10. NYSDOT Contingency Percentages.**

| Project Phase | Contingency (%) |
|---|---|
| Planning | 25 – 40 |
| Scoping | 20 – 25 |
| Design | 15 – 20 |
| PS&E | 5 -10 |

**Florida Department of Transportation**

General Section

Historical bid-based estimating is FDOT's primary estimating technique used in the PS&E phase of the project development. Estimators use the Lane Mile Cost information developed from the Long Range Estimation (LRE) system for preparing the Planning level estimates. The LRE is extensively used in the scoping and early design phases (see Figure 53). The District offices prepare the Engineer's Estimate using the CES of Trns*port system.

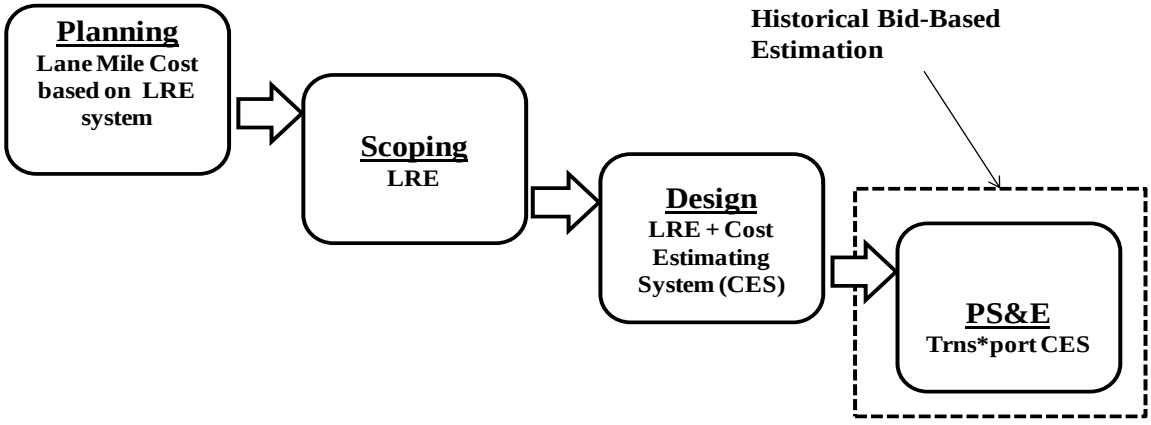



**Figure 53. FDOT Estimation Framework.**

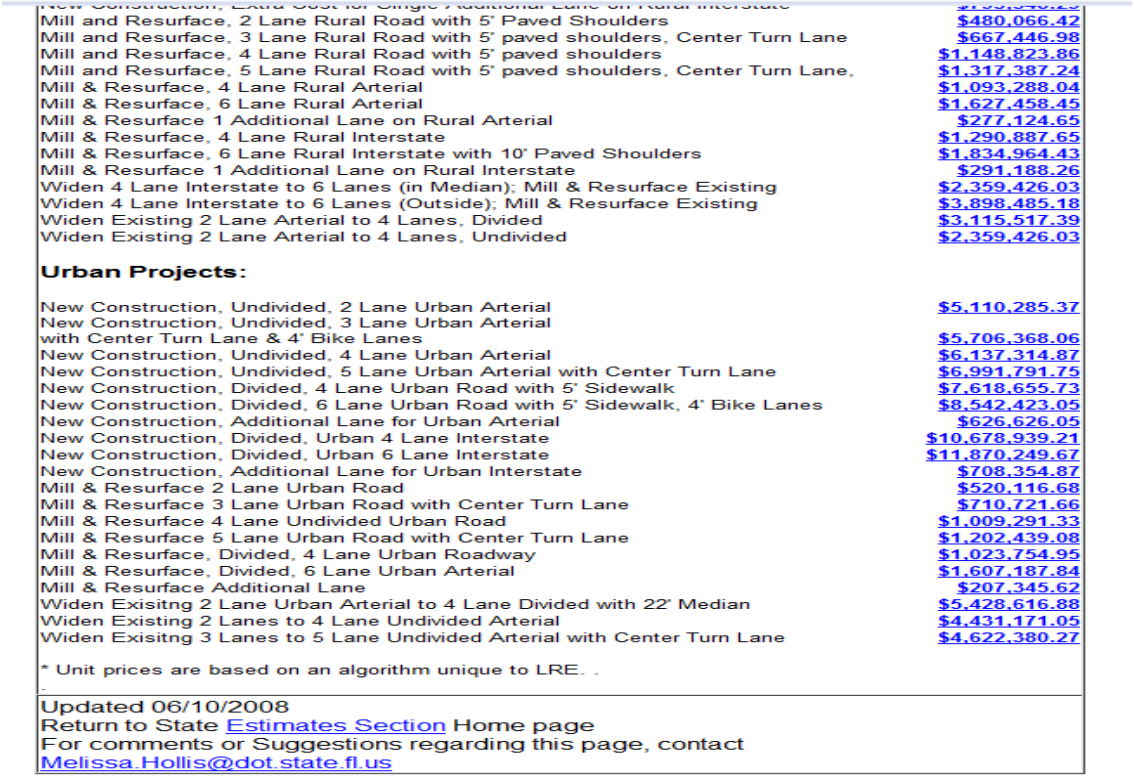
The lane mile cost information is available for different types of rural and urban projects. The unit price used to develop lane mile costs as reflected in the estimate represents statewide averages. This information is available as a reference and not to be used to predict future costs. Generic Cost per Mile (Figure 54 and Figure 55) models developed is available on FDOT's website at http://www.dot.state.fl.us/estimates /LaneMileCosts/LaneMilecosts.htm.

**Generic Cost Per Mile Models**
**Statewide Average Unit Prices* for**
**May 2007 - April 2008**

**Disclaimer:** These models are generic in nature, and not based on actual construction projects. They are for reference purposes only, and are not intended to predict future costs

| Models | Cost Per Mile |
|---|---|
| | Select Cost Per Mile total links below for model details. |
| **Rural Projects:** | |
| New Construction, Undivided, 2 Lane Rural Road with 5' Shoulders | $2,434,948.91 |
| New Construction, Undivided, 3 Lane Rural Road with 5' Shoulders, Center Turn Lane | $2,932,026.07 |
| New Construction, Undivided, 4 Lane Rural Road with 5' Paved Shoulders | $3,515,821.36 |
| New Construction, Undivided, 5 Lane Rural Road with 5' Shoulders, Center Turn Lane | $4,150,428.02 |
| New Construction, Divided, 4 Lane Rural Road with 5' Paved Shoulders | $4,793,349.03 |
| New Construction, Divided, 6 Lane Rural Road with 5' Paved Shoulders | $5,838,898.50 |
| New Construction, Extra Cost for Single Additional Lane on Rural Arterial | $659,129.07 |
| New Construction, Divided, Rural 4 Lane Interstate | $5,902,704.56 |
| New Construction, Divided, Rural 6 Lane Interstate | $6,910,830.67 |
| New Construction, Extra Cost for Single Additional Lane on Rural Interstate | $793,348.29 |
| Mill and Resurface, 2 Lane Rural Road with 5' Paved Shoulders | $480,066.42 |
| Mill and Resurface, 3 Lane Rural Road with 5' paved shoulders, Center Turn Lane | $667,446.98 |
| Mill and Resurface, 4 Lane Rural Road with 5' paved shoulders | $1,148,823.86 |
| Mill and Resurface, 5 Lane Rural Road with 5' paved shoulders, Center Turn Lane, | $1,317,387.24 |
| Mill & Resurface, 4 Lane Rural Arterial | $1,093,288.04 |
| Mill & Resurface, 6 Lane Rural Arterial | $1,627,458.45 |
| Mill & Resurface 1 Additional Lane on Rural Arterial | $277,124.65 |
| Mill & Resurface, 4 Lane Rural Interstate | $1,290,887.65 |
| Mill & Resurface, 6 Lane Rural Interstate with 10' Paved Shoulders | $1,834,964.43 |
| Mill & Resurface 1 Additional Lane on Rural Interstate | $291,188.26 |
| Widen 4 Lane Interstate to 6 Lanes (in Median); Mill & Resurface Existing | $2,359,426.03 |
| Widen 4 Lane Interstate to 6 Lanes (Outside); Mill & Resurface Existing | $3,898,485.18 |
| Widen Existing 2 Lane Arterial to 4 Lanes, Divided | $3,115,517.39 |
| Widen Existing 2 Lane Arterial to 4 Lanes, Undivided | $2,359,426.03 |
| **Urban Projects:** | |
| New Construction, Undivided, 2 Lane Urban Arterial | $5,110,285.37 |
| New Construction, Undivided, 3 Lane Urban Arterial with Center Turn Lane & 4' Bike Lanes | $5,706,368.06 |
| New Construction, Undivided, 4 Lane Urban Arterial | $6,137,314.87 |
| New Construction, Undivided, 5 Lane Urban Arterial with Center Turn Lane | $6,991,791.75 |
| New Construction, Divided, 4 Lane Urban Road with 5' Sidewalk | $7,618,655.73 |
| New Construction, Divided, 6 Lane Urban Road with 5' Sidewalk, 4' Bike Lanes | $8,542,423.05 |

**Figure 54. FDOT Generic Cost per Mile Model - Rural Projects. (FDOT 2008a)**



| | |
|---|---|
| Mill and Resurface, 2 Lane Rural Road with 5' Paved Shoulders | $480,066.42 |
| Mill and Resurface, 3 Lane Rural Road with 5' paved shoulders, Center Turn Lane | $667,446.98 |
| Mill and Resurface, 4 Lane Rural Road with 5' paved shoulders | $1,148,823.86 |
| Mill and Resurface, 5 Lane Rural Road with 5' paved shoulders, Center Turn Lane, | $1,317,387.24 |
| Mill & Resurface, 4 Lane Rural Arterial | $1,093,288.04 |
| Mill & Resurface, 6 Lane Rural Arterial | $1,627,458.45 |
| Mill & Resurface 1 Additional Lane on Rural Arterial | $277,124.65 |
| Mill & Resurface, 4 Lane Rural Interstate | $1,290,887.65 |
| Mill & Resurface, 6 Lane Rural Interstate with 10' Paved Shoulders | $1,834,964.43 |
| Mill & Resurface 1 Additional Lane on Rural Interstate | $291,188.26 |
| Widen 4 Lane Interstate to 6 Lanes (in Median); Mill & Resurface Existing | $2,359,426.03 |
| Widen 4 Lane Interstate to 6 Lanes (Outside); Mill & Resurface Existing | $3,898,485.18 |
| Widen Existing 2 Lane Arterial to 4 Lanes, Divided | $3,115,517.39 |
| Widen Existing 2 Lane Arterial to 4 Lanes, Undivided | $2,359,426.03 |
| **Urban Projects:** | |
| New Construction, Undivided, 2 Lane Urban Arterial | $5,110,285.37 |
| New Construction, Undivided, 3 Lane Urban Arterial with Center Turn Lane & 4' Bike Lanes | $5,706,368.06 |
| New Construction, Undivided, 4 Lane Urban Arterial | $6,137,314.87 |
| New Construction, Undivided, 5 Lane Urban Arterial with Center Turn Lane | $6,991,791.75 |
| New Construction, Divided, 4 Lane Urban Road with 5' Sidewalk | $7,618,655.73 |
| New Construction, Divided, 6 Lane Urban Road with 5' Sidewalk, 4' Bike Lanes | $8,542,423.05 |
| New Construction, Additional Lane for Urban Arterial | $626,626.05 |
| New Construction, Divided, Urban 4 Lane Interstate | $10,678,939.21 |
| New Construction, Divided, Urban 6 Lane Interstate | $11,870,249.67 |
| New Construction, Additional Lane for Urban Interstate | $708,354.87 |
| Mill & Resurface 2 Lane Urban Road | $520,116.68 |
| Mill & Resurface 3 Lane Urban Road with Center Turn Lane | $710,721.66 |
| Mill & Resurface 4 Lane Undivided Urban Road | $1,009,291.33 |
| Mill & Resurface 5 Lane Urban Road with Center Turn Lane | $1,202,439.08 |
| Mill & Resurface, Divided, 4 Lane Urban Roadway | $1,023,754.95 |
| Mill & Resurface, Divided, 6 Lane Urban Arterial | $1,607,187.84 |
| Mill & Resurface Additional Lane | $207,345.62 |
| Widen Exisitng 2 Lane Urban Arterial to 4 Lane Divided with 22' Median | $5,428,616.88 |
| Widen Existing 2 Lanes to 4 Lane Undivided Arterial | $4,431,171.05 |
| Widen Exisitng 3 Lanes to 5 Lane Undivided Arterial with Center Turn Lane | $4,622,380.27 |

* Unit prices are based on an algorithm unique to LRE. .

Updated 06/10/2008
Return to State Estimates Section Home page
For comments or Suggestions regarding this page, contact
Melissa.Hollis@dot.state.fl.us

**Figure 55. FDOT Generic Cost per Mile Model - Urban Projects. (FDOT 2008a)**

### *Long Range Estimation System*

FDOT uses its LRE system, developed in-house, to prepare project estimates in the scoping and design phase. The Generic Cost per Mile models shown in Figure 54 and Figure 55 are generated using LRE system. LRE uses the same historical database as CES and generates a twelve-month rolling average for each pay item. It also provides the estimators with the statewide, county, and market area averages for a particular pay item. A market area is a grouping of counties based on similar bidding practices within districts. The rolling average is updated annually with new bid information.

FDOT utilizes the LRE system for preparing the estimates in the Design phase until the 60 percent of design completion point. When more than 60 percent of the design details are available, FDOT uses CES to build the estimate. FDOT does not have any guidance on the development of unit costs. FDOT is looking at using a cost-based estimating approach to estimate major pay items when preparing the Engineer's Estimate.

Acquiring Unit Cost Information

FDOT uses BAMS/DSS to acquire bid information from all the submitted bids.

Storing Unit Cost Information

FDOT stores all its historical unit costs in their BAMS/DSS system. Over five years of historical unit costs are stored in their database. Historical unit costs are available based on statewide, district, and market areas. All the historical unit costs are stored based on standard construction line items.

Accessing Unit Cost Information

FDOT maintains nine different cost history libraries used in the Trns*port CES. The libraries consist of recent six months, eighteen months, and thirty six months historical bid details for low bidders only, all bidders, contracts less than two years, and contracts greater than two years. FDOT offers annual statewide averages (see Figure 56) for all pay items using historical data stored in BAMS/DSS and also averages for various market areas (see Figure 57) on its website.

CESP005 05/12/2009-09.39.59 Page:

Florida Department of Transportation
Item Average Unit Cost
From 2007/01/01 to 2007/12/31

Contract Type: ('CC') STATEWIDE
Displaying: VALID ITEMS WITH HITS
From: 0100 To: 1999999999

| Item | No. of Conts | Weighted Average | Total Amount | Total Quantity | Unit Meas | Obs? | Description |
|---|---|---|---|---|---|---|---|
| 0101 1 | 255 | $421,924.77 | $135,859,775.35 | 322.000 | LS | N | MOBILIZATION |
| 0102 1 | 255 | $863.19 | $66,784,873.67 | 77,370.000 | DA | N | MAINTENANCE OF TRAFFIC |
| 0102 2 1 | 9 | $342,030.12 | $3,420,301.21 | 10.000 | LS | N | SPECIAL DETOUR 1 |
| 0102 2 2 | 5 | $592,987.85 | $2,964,939.23 | 5.000 | LS | N | SPECIAL DETOUR 2 |
| 0102 2 3 | 4 | $915,067.38 | $3,660,269.51 | 4.000 | LS | N | SPECIAL DETOUR 3 |
| 0102 2 4 | 4 | $223,163.93 | $892,655.72 | 4.000 | LS | N | SPECIAL DETOUR 4 |
| 0102 2 5 | 2 | $112,500.00 | $225,000.00 | 2.000 | LS | N | SPECIAL DETOUR 5 |
| 0102 2 6 | 1 | $50,000.00 | $50,000.00 | 1.000 | LS | N | SPECIAL DETOUR 6 |
| 0102 2 7 | 1 | $50,000.00 | $50,000.00 | 1.000 | LS | N | SPECIAL DETOUR 7 |
| 0102 3 | 65 | $26.94 | $1,446,579.53 | 53,699.800 | CY | N | COMMERCIAL MATL FOR DRIVEWAY MAINT |
| 0102 14 | 113 | $51.76 | $1,426,815.42 | 27,564.000 | MH | N | TRAFFIC CONTROL OFFICER |
| 0102 60 | 241 | $.29 | $1,301,225.68 | 4,490,720.000 | ED | N | WORK ZONE SIGN |
| 0102 61 | 49 | $37.42 | $89,387.81 | 2,389.000 | EA | N | BUSINESS SIGN |
| 0102 71 11 | 55 | $21.66 | $6,545,609.63 | 302,161.750 | LF | N | BARRIER WALL,TEMP,F&I,CONCRETE |
| 0102 71 12 | 4 | $40.37 | $109,039.09 | 2,701.000 | LF | N | BARRIER WALL,TEMP,F&I,WATERFILLED |
| 0102 71 13 | 14 | $48.62 | $2,794,112.32 | 57,469.000 | LF | N | BARRIER WALL,TEMP,F&I,LOW PROFILE,CONC |

**Figure 56. FDOT Annual Statewide Averages. (FDOT 2008b)**

CESP005 01/17/2009-10.16.24 Page:

Florida Department of Transportation
Item Average Unit Cost
From 2007/01/01 to 2007/12/31

Contract Type: ('CC') AREAS :01
Displaying: VALID ITEMS WITH HITS
From: 0100 To: 1999999999

| Item | No. of Conts | Weighted Average | Total Amount | Total Quantity | Unit Meas | Obs? | Description |
|---|---|---|---|---|---|---|---|
| 0101 1 | 16 | $274,616.61 | $4,943,099.00 | 18.000 | LS | N | MOBILIZATION |
| 0102 1 | 16 | $487.78 | $2,074,031.10 | 4,252.000 | DA | N | MAINTENANCE OF TRAFFIC |
| 0102 2 1 | 1 | $325,000.00 | $650,000.00 | 2.000 | LS | N | SPECIAL DETOUR 1 |
| 0102 3 | 6 | $27.72 | $135,920.19 | 4,904.000 | CY | N | COMMERCIAL MATL FOR DRIVEWAY MAINT |
| 0102 14 | 3 | $47.55 | $6,847.04 | 144.000 | MH | N | TRAFFIC CONTROL OFFICER |
| 0102 60 | 16 | $.48 | $63,052.01 | 132,712.000 | ED | N | WORK ZONE SIGN |
| 0102 61 | 2 | $330.34 | $3,633.75 | 11.000 | EA | N | BUSINESS SIGN |
| 0102 71 11 | 5 | $12.23 | $334,329.00 | 27,335.000 | LF | N | BARRIER WALL,TEMP,F&I,CONCRETE |
| 0102 71 14 | 1 | $49.00 | $245,490.00 | 5,010.000 | LF | N | BARRIER WALL,TEMP,F&I,TYPE K |
| 0102 71 21 | 4 | $5.81 | $176,612.10 | 30,411.000 | LF | N | BARRIER WALL,TEMP,REL,CONCRETE |
| 0102 73 | 1 | $18.00 | $18,900.00 | 1,050.000 | LF | N | TEMPORARY GUARDRAIL |
| 0102 74 1 | 11 | $.22 | $75,655.32 | 347,632.000 | ED | N | BARRICADE,TEMP,TYPS I,II,DI,VP & DRUM |
| 0102 74 2 | 7 | $.91 | $4,179.02 | 4,594.000 | ED | N | BARRICADE,TEMP,TYPE III, 6' |
| 0102 76 | 7 | $10.70 | $35,327.00 | 3,303.000 | ED | N | ADVANCE WARNING ARROW PANEL |
| 0102 77 | 16 | $.62 | $38,199.60 | 61,381.000 | ED | N | HIGH INTENSITY FLASH LI,TEMP,TYP B |
| 0102 78 | 7 | $4.60 | $174,295.33 | 37,924.000 | EA | N | REFLECTIVE PAVT MARKER,TEMPORARY |
| 0102 79 | 6 | $.22 | $14,238.58 | 63,871.000 | ED | N | LIGHTS,BARR WALL MNT,TEMP,TYP C,STDY BRN |

**Figure 57. FDOT Annual Market Areas Averages. (FDOT 2008b)**

Applying Unit Cost Information

FDOT uses four to six months of historical bid data for establishing the unit prices. LRE and CES enable the estimator to select a weighted average or use a scatter plot when determining the unit prices for both major and minor items of work. LRE also provides estimators with statewide, county, and market area averages from which to choose unit costs for each pay item. Though this approach is just guidance on the prices based on historical data, the estimators have the option to override the unit price if it is not consistent with current market conditions. The libraries with contracts greater than two years duration have inflation built into the unit costs.

FDOT does not have any guidance on adjusting unit prices based on project complexity, size, current market conditions, and inflation but relies on experience and engineering judgment to adjust unit prices. Estimators handle uncertainties within the project by using contingencies varying from 25 percent at the planning phase to 0–5 percent in the final PS&E phase of project development.

**Washington State Department of Transportation**

General Section

WSDOT relies on historical bid-based estimating to prepare the estimates in the planning, scoping, and design phases of project development (see Figure 58). The Final Engineer's Estimate is developed using a combination of cost based and historical bid-based estimating. The use of cost based approach is limited to those items of work that comprise the largest dollar value of the project, typically that 20 percent of items of

work containing 80 percent of project cost. Along with the above two estimating techniques, WSDOT also uses the parametric estimating approach for planning level estimates. The planning level estimates are prepared using two tools that employ parametric methods: 1) Mobility Project Prioritization Process (MP3) and 2) Planning Level Project Cost Estimating (PLCE). Estimates in the scoping, design, and PS&E phases are prepared using WSDOT's in-house estimating system called Estimate and Bid Analysis System (EBASE). Along with EBASE, WSDOT uses the Bid Tabs Pro® software of Oman Systems to help in preparing the design level and Engineers Estimates. Figure 58 shows the estimating tools used by WSDOT in various project development phases.

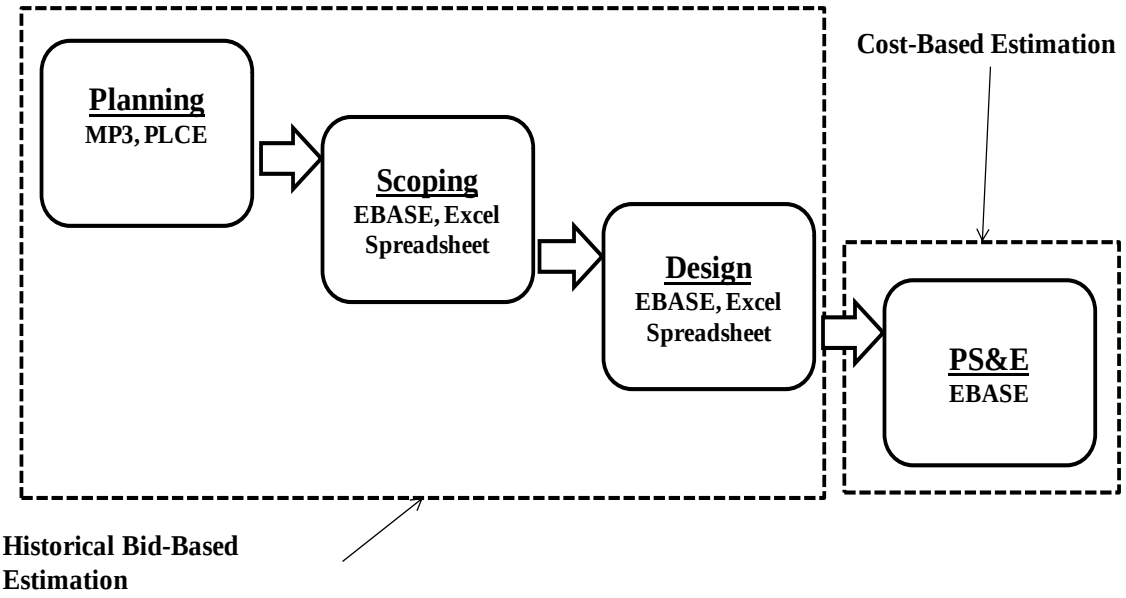



**Figure 58. WSDOT Estimation Framework.**

WSDOT maintains a manual providing cost estimating guidelines on its website at http://www.WSDOT.wa.gov/Projects/ProjectMgmt/RiskAssessment/Process/ under the Estimating section. The guideline provides an overview of the estimating techniques used by WSDOT during different project development phases and explains the factors affecting the unit prices.

Acquiring Unit Cost Information

Historical bid data from bid tabulations are directly imported into the EBASE system. The bid information from all the submitted bids is stored in the database.

Storing Unit Cost Information

WSDOT maintains over five years of historical data within their EBASE system. Historical bid details are also transferred to Oman systems for building their Bid Tabs Pro database. EBASE holds data for the entire state, districts/regions, and counties. Apart from storing historical unit costs as standard construction line items, WSDOT also has them categorized based on different work categories (e.g., grading/excavation, asphalt, bridge, traffic control, etc.) and based on project types (e.g., bridge replacement, lane widening, intersection reconstruction, etc.).

Accessing Unit Cost Information

WSDOT's Unit Bid Analysis system allows access to historical unit costs. This in-house developed system contains the bid history for standard bid items used in their projects. This history consists of listing of projects in which bid items were used, the three low bidders' information, quantities, and units of measurement. Unit Bid Analysis can be accessed on their webpage at http://www.WSDOT.wa.gov/Design/ProjectDev/

EngineeringApplications/UnitBidHistory.htm. The 'Search' hyperlink on the webpage lets the user specify standard item name or number, the region, the measurement system (English or Metric) and the date range for the inquiry. The results can be viewed online or can be downloaded as an Excel spreadsheet. Figure 59 shows the Unit Bid Analysis system for searching WSDOT's historical database, and Figure 60 shows the result of the inquiry.

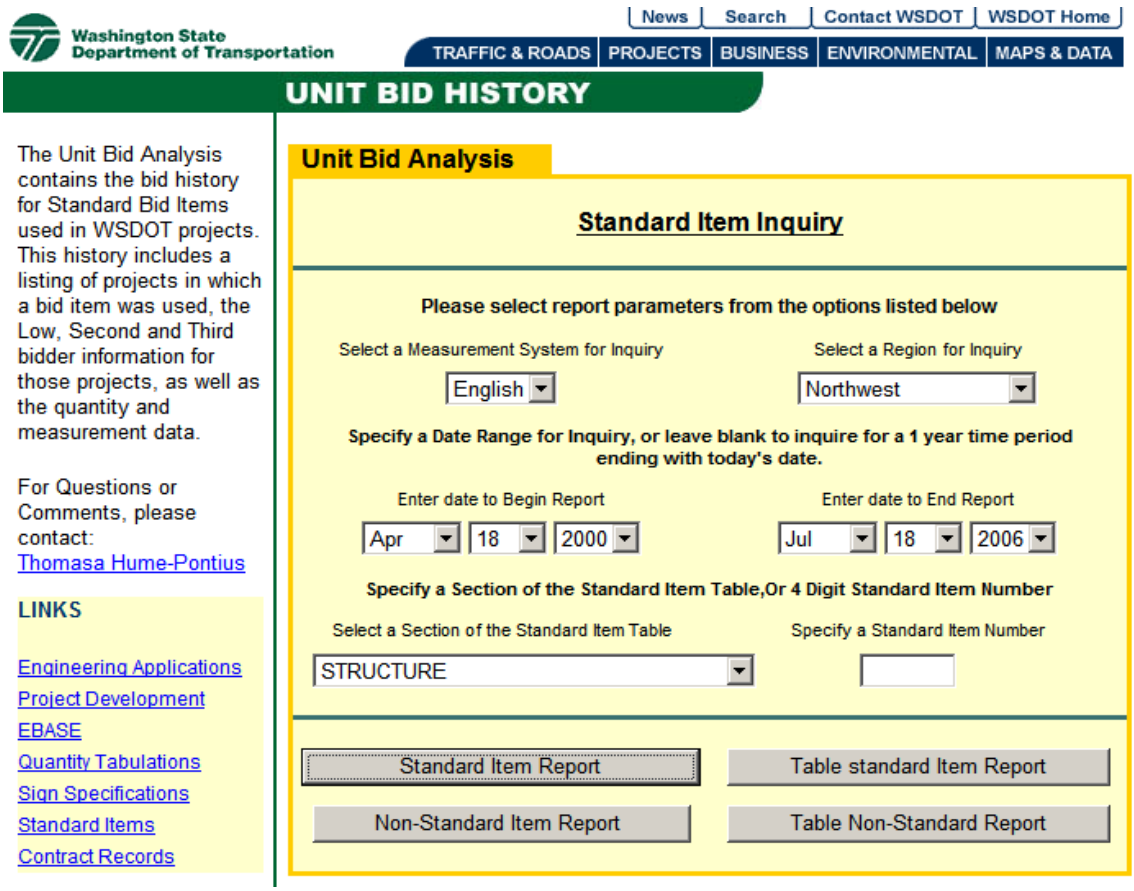
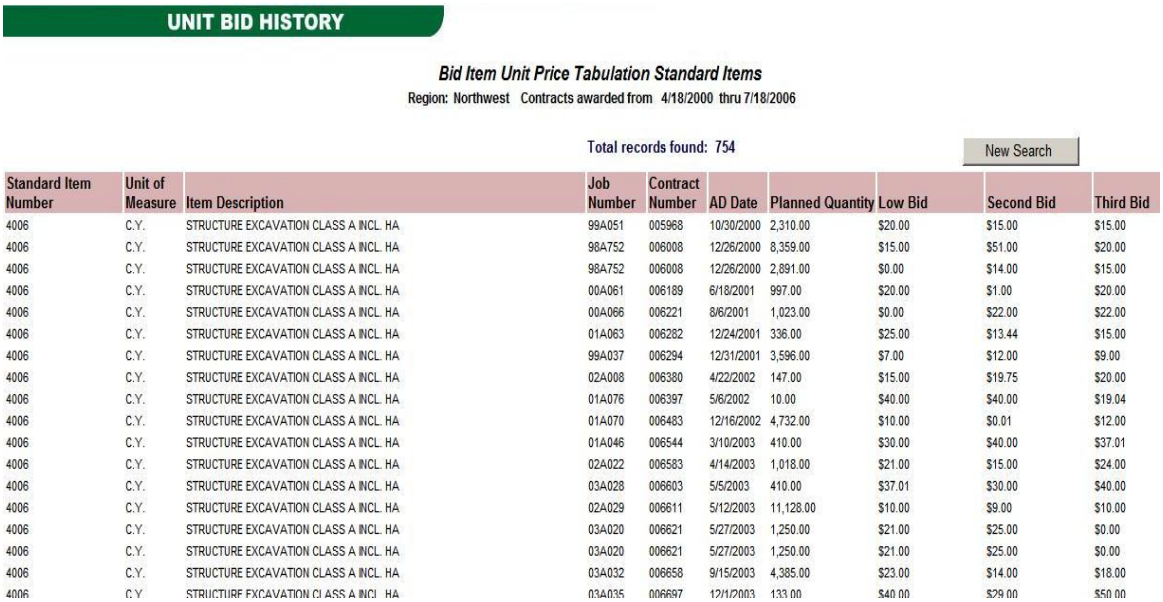



**Figure 59. WSDOT Unit Bid Analysis. (WSDOT 2008b)**



UNIT BID HISTORY

*Bid Item Unit Price Tabulation Standard Items*

Region: Northwest Contracts awarded from 4/18/2000 thru 7/18/2006

Total records found: 754 New Search

| Standard Item Number | Unit of Measure | Item Description | Job Number | Contract Number | AD Date | Planned Quantity | Low Bid | Second Bid | Third Bid |
|---|---|---|---|---|---|---|---|---|---|
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 99A051 | 005968 | 10/30/2000 | 2,310.00 | $20.00 | $15.00 | $15.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 98A752 | 006008 | 12/26/2000 | 8,359.00 | $15.00 | $51.00 | $20.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 98A752 | 006008 | 12/26/2000 | 2,891.00 | $0.00 | $14.00 | $15.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 00A061 | 006189 | 6/18/2001 | 997.00 | $20.00 | $1.00 | $20.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 00A066 | 006221 | 8/6/2001 | 1,023.00 | $0.00 | $22.00 | $22.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 01A063 | 006282 | 12/24/2001 | 336.00 | $25.00 | $13.44 | $15.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 99A037 | 006294 | 12/31/2001 | 3,596.00 | $7.00 | $12.00 | $9.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 02A008 | 006380 | 4/22/2002 | 147.00 | $15.00 | $19.75 | $20.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 01A076 | 006397 | 5/6/2002 | 10.00 | $40.00 | $40.00 | $19.04 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 01A070 | 006483 | 12/16/2002 | 4,732.00 | $10.00 | $0.01 | $12.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 01A046 | 006544 | 3/10/2003 | 410.00 | $30.00 | $40.00 | $37.01 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 02A022 | 006583 | 4/14/2003 | 1,018.00 | $21.00 | $15.00 | $24.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 03A028 | 006603 | 5/5/2003 | 410.00 | $37.01 | $30.00 | $40.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 02A029 | 006611 | 5/12/2003 | 11,128.00 | $10.00 | $9.00 | $10.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 03A020 | 006621 | 5/27/2003 | 1,250.00 | $21.00 | $25.00 | $0.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 03A020 | 006621 | 5/27/2003 | 1,250.00 | $21.00 | $25.00 | $0.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 03A032 | 006658 | 9/15/2003 | 4,385.00 | $23.00 | $14.00 | $18.00 |
| 4006 | C.Y. | STRUCTURE EXCAVATION CLASS A INCL. HA | 03A035 | 006697 | 12/1/2003 | 133.00 | $40.00 | $29.00 | $50.00 |

**Figure 60. Unit Bid Analysis - Inquiry Results. (WSDOT 2008b)**

WSDOT also uses Bid Tabs Pro, developed by Oman Systems, for accessing historical bid details. The database for this system is built using the historical data stored in EBASE. Unlike the Unit Bid Analysis system, Bid Tabs Pro lets the user generate historical reports based on different search criterions such as:

- By contractor
- By job
- By pay item
- Compare 2 con (contractors)
- PI (Pay Item) search
- Letting report
- Con (contractor) analysis

- Comp analysis
- Market analysis

The search by pay item option (see Figure 61) lets the estimator specify the number of bids to be included in the search (e.g., all bids, low bid, low two, or low three bids), the counties and regions, and the quantity range and the project size (in dollars). Figure 62 shows typical output for a search requested based on input parameters of interest.

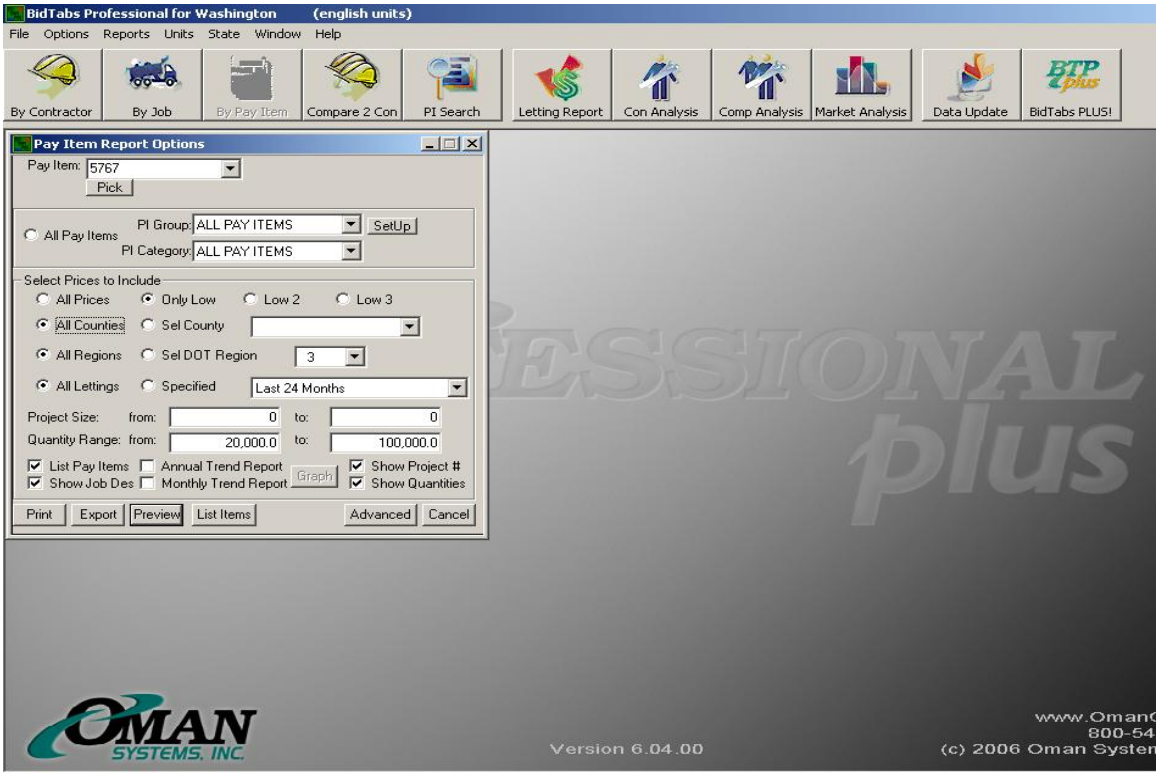



**Figure 61. WSDOT Bid Tabs Pro - Search By Pay Item. (WSDOT 2008c)**

Pay Item: 5767 HMA CL. 1/2 IN. PG 70-28

| TOTALS | High: | 63.89 | Wtd. Average: | 43.17 | Total Quan: | 1,136,385.90 | Count: | 30 |
|---|---|---|---|---|---|---|---|---|
| | Low: | 26.50 | Strt. Average: | 43.21 | Avg. Quan: | 37,879.53 | Median: | 41.43 |
| | | | Std Deviation: | 11.70 | | | | |

| Contractor | Project No. | County | Position | Bid Date | Quantity | Unit | Unit Price | Extension |
|---|---|---|---|---|---|---|---|---|
| inland asphalt co, a div of icon | 006999<br>us 2 houston ave. to center rd. pav | spokane | 1 | 06/16/2005 | 26,920.00 | TON | 38.00 | 1,022,960.00 |
| wilder construction company | 006994<br>sr 9 sr 522 to 212th st se widening | snohomish | 1 | 07/13/2005 | 52,564.00 | TON | 48.00 | 2,523,072.00 |
| central washington asphalt, inc. | 007031<br>sr 281 quincy south paving 06b001 | grant | 1 | 10/06/2005 | 22,968.00 | TON | 33.00 | 757,944.00 |
| scarsella bros. inc. | 007032<br>sr 3 sr 303 interchange 04c504 | kitsap | 1 | 10/19/2005 | 26,720.00 | TON | 55.00 | 1,469,600.00 |
| tri-state construction, inc. | 007030<br>sr 202 sr 520 to sahalee way wideni | king | 1 | 11/30/2005 | 45,178.90 | TON | 55.00 | 2,484,839.50 |
| central washington asphalt, inc. | 007056<br>sr 28 rock island to crescent bar p | douglas | 1 | 12/01/2005 | 27,410.00 | TON | 30.00 | 822,300.00 |
| imco general construction, inc. | 007078<br>sr 9 nooksack rd vic to cherry st | whatcom | 1 | 02/23/2006 | 46,300.00 | TON | 56.14 | 2,599,282.00 |
| ace paving co., inc. | 007098<br>us 101 brockdale rd to skookum cree | mason | 1 | 02/23/2006 | 46,860.00 | TON | 51.00 | 2,389,860.00 |
| tucci & sons, inc. | 007099<br>sr 512 104th st. e. to sr 167 o/c | pierce | 1 | 03/08/2006 | 25,030.00 | TON | 45.80 | 1,146,374.00 |
| inland asphalt co, a div of icon | 007080<br>sr 167 15th st sw to s 180th st sta | king | 1 | 03/08/2006 | 54,478.00 | TON | 55.00 | 2,996,290.00 |
| ace paving co., inc. | 007123<br>sr 305 ferry terminal to hostmark s | kitsap | 1 | 04/12/2006 | 32,900.00 | TON | 57.76 | 1,900,304.00 |
| lakeside industries | 007125<br>sr 20, sr 104, sr 116 state highway | jefferson | 1 | 04/12/2006 | 55,795.00 | TON | 58.49 | 3,263,449.55 |
| wilder construction company | 007134<br>i-5 52nd ave w to sr 526 sb paving | snohomish | 1 | 05/03/2006 | 28,853.00 | TON | 62.50 | 1,803,312.50 |
| lakeside industries | 007140<br>us 12 corn creek bridge vicinity to | lewis | 1 | 05/03/2006 | 27,490.00 | TON | 59.00 | 1,621,910.00 |
| apollo, inc. | 007082<br>us 12 attalia vic. - add lanes 05 | walla walla | 1 | 05/24/2006 | 43,980.00 | TON | 63.89 | 2,809,882.20 |

**Figure 62. WSDOT Bid Tabs Pro - Search Results (By Pay Item). (WSDOT 2008c)**

Another search option uses the "By Job" criteria. The estimators can review all the bids or just the bid data for the low bidder based on a job number, as shown in Figure 63. The output of this search (see Figure 64) provides a list of line items used by the winning bidder for that particular job id.

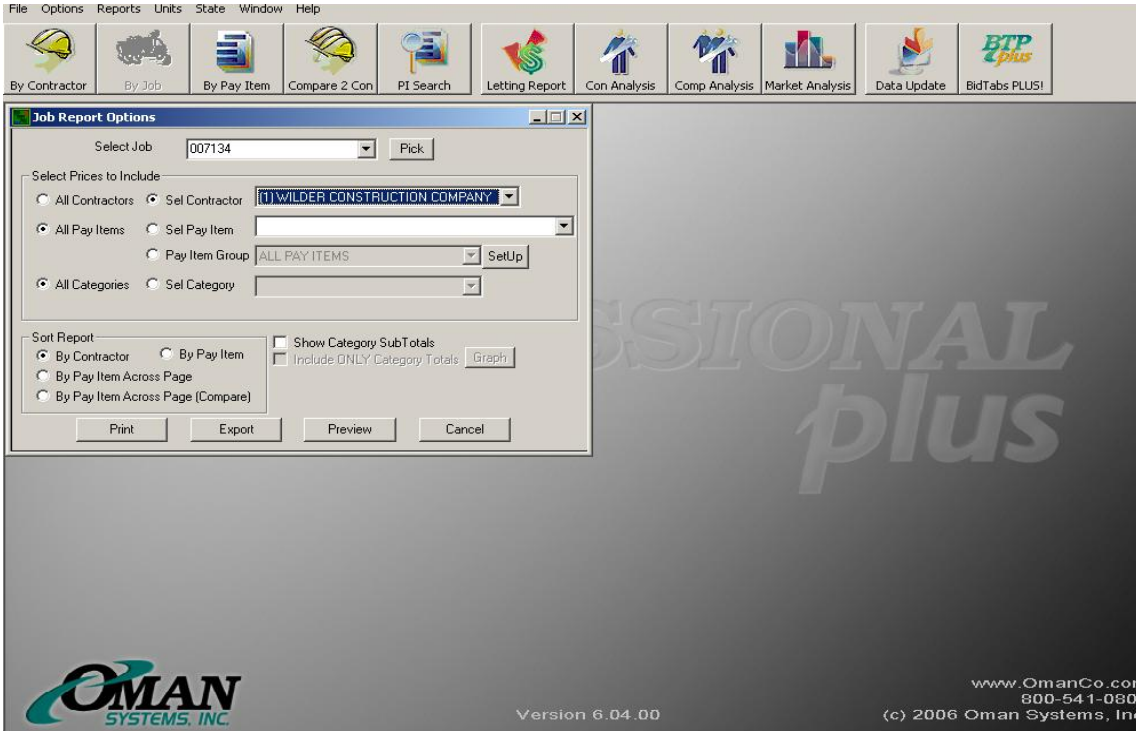



**Figure 63. WSDOT Bid Tabs Pro - Search by Job. (WSDOT 2008c)**

WASHINGTON
JOB REPORT

WSDOT — Date: 06/03/2006 Time: 10:39:30

**Job#: 007134** **county: SNOHOMISH** **biddate: 05/03/2006**

| Pay Item | Description | Quantity | Unit | Unit Price | Total |
|---|---|---|---|---|---|
| contractor: 911467716 | WILDER CONSTRUCTION COMPANY | position: 1 | | | |
| 0001 | Mobilization | 1.000 | L.S. | 565,000.00 | 565,000.00 |
| 0025 | Clearing And Grubbing | 0.900 | ACRE | 15,000.00 | 13,500.00 |
| 0049 | Removing Drainage Structure | 1.000 | EACH | 1,124.96 | 1,124.96 |
| 0061 | Removing Portion Of Existing Bridge | 1.000 | L.S. | 10,000.00 | 10,000.00 |
| 0145 | Removing Conc. Barrier | 570.000 | L.F. | 5.00 | 2,850.00 |
| 0170 | Removing Guardrail | 1,886.000 | L.F. | 3.00 | 5,658.00 |
| 0182 | Removing Guardrail Anchor | 16.000 | EACH | 180.00 | 2,880.00 |
| 0187 | Removing Paint Line | 23,630.000 | L.F. | 0.60 | 14,178.00 |
| 0190 | Removing Plastic Line | 200.000 | L.F. | 1.00 | 200.00 |
| 0208 | Removing Raised Pavement Marker | 132.000 | 100EA | 90.00 | 11,880.00 |
| 007134(1) | Removing Traffic Island | 30.000 | S.Y. | 24.00 | 720.00 |
| 0310 | Roadway Excavation Incl. Haul | 2,360.000 | C.Y. | 20.00 | 47,200.00 |
| 0330 | Roadway Excavation Incl. Haul - Area | 410.000 | C.Y. | 40.00 | 16,400.00 |
| 0332 | Pavement Repair Excavation Incl. Haul | 689.000 | S.Y. | 30.00 | 20,670.00 |
| 0408 | Select Borrow Incl. Haul | 720.000 | TON | 17.00 | 12,240.00 |
| 0470 | Embankment Compaction | 210.000 | C.Y. | 9.00 | 1,890.00 |
| 1086 | Quarry Spalls | 9.000 | TON | 75.00 | 675.00 |
| 1160 | Underdrain Pipe 6 In. Diam. | 358.000 | L.F. | 21.00 | 7,518.00 |
| 1170 | Drain Pipe 6 In. Diam. | 42.000 | L.F. | 25.00 | 1,050.00 |
| 3091 | Catch Basin Type 1 | 7.000 | EACH | 1,200.00 | 8,400.00 |
| 3105 | Catch Basin Type 2 48 In. Diam. | 1.000 | EACH | 2,600.00 | 2,600.00 |
| 3151 | Testing Storm Sewer Pipe | 1,268.000 | L.F. | 2.00 | 2,536.00 |
| 3541 | Schedule A Storm Sewer Pipe 12 In. | 1,268.000 | L.F. | 22.00 | 27,896.00 |
| 4025 | Gravel Backfill For Wall | 187.000 | C.Y. | 48.00 | 8,976.00 |
| 5100 | Crushed Surfacing Base Course | 3,800.000 | TON | 26.00 | 98,800.00 |
| 5334 | Anti-Stripping Additive | 1.000 | EST. | 33,010.00 | 33,010.00 |
| 5703 | Crack Sealing | 1.000 | EST. | 10,830.00 | 10,830.00 |
| 5711 | Planing Bituminous Pavement | 230,790.000 | S.Y. | 1.50 | 346,185.00 |
| 5739 | Hma For Pavement Repair Cl. 1/2 In. Pg | 298.000 | TON | 88.00 | 26,224.00 |

**Figure 64. WSDOT Bid Tabs Pro – Search Results (By Job). (WSDOT 2008c)**

Applying Unit Cost Information

WSDOT considers three to six months of historical data for establishing the unit prices, with Unit Bid Analysis and Bid Tabs Pro providing the estimators with the necessary historical prices for estimation. The estimating guideline of WSDOT identifies the important factors influencing the development of unit prices. Some of the important factors include:

- Geographic Consideration – The location of the project, urban or rural, distance from location of material sources affects the unit price accordingly.
- Quantity Consideration – Large quantities of a given material leads to lesser unit prices. Very large quantities of certain materials might lead to an increase in the unit prices.
- Item Availability – Readily available items cost less than materials that are in short supply.
- Scheduling/ Lead Time – Contractors schedule their resources to be more efficient and competitive in their bidding. As a result, the lead time should be considered when preparing the estimates based upon the time when it is to be actually built.
- Difficult Construction/ Site Constraints – Increases the construction cost for the contractor.
- Estimating Lump Sum Items – The contractors take on extra risk due to the use of lump sum items and as a result increase the unit price to counter the extra risk.

- Force Account – The contractors do not bid on force account items, as there is less incentive to reduce cost or perform the work diligently. When using force account items, the estimator should try to establish the scope of work to be performed.
- Timing of Advertisement – The timing of advertisement and fluctuations of bid prices due to different seasons affect the unit prices.
- Expected Competition/ Contractor Availability – Projects scheduled late in the year after the contractors have scheduled their work for the year increases the bid prices.
- Specialty Work/ First Time Used – Projects having first time used items or specialty works have to adjust for contractor's lack of experience with the item and the potential increased risk in construction.

The estimating guideline provides the estimators only with factors to be considered when establishing the unit prices, but the adjustment of unit costs is still largely based on engineering judgment and experience of the estimators.

**Texas Department of Transportation**

General Section

TxDOT uses the historical bid-based estimation technique to prepare cost estimates from the planning phase through the PS&E phase of project development. Preliminary estimates are prepared using Excel spreadsheet in all the three districts (Bryan, Dallas, and Fort Worth). Estimators update the same Excel spreadsheet until the

design phase is reached. Fort Worth is the only district, of the three interviewed, using Trns*port Estimator to prepare estimates during the design phase. The Bryan district extensively uses the Trns*port Estimator to prepare Engineer's Estimate whereas in Dallas and Fort Worth, Estimator is used by the consultants to prepare the estimates. The Engineer's Estimates are updated into the Design and Construction Information System (DCIS) residing within their ROSCOE system. DCIS is a mainframe system used by TxDOT for managing the project estimates and permits changing the unit prices and quantities. ROSCOE then draws information from DCIS to generate the bid documents furnished to contractors. ROSCOE does this by listing primary bid items and their quantities. Figure 65 shows the estimation framework used within TxDOT, and Figure 66 shows the interaction between ROSCOE, DCIS, Trns*port Estimator, and the Excel spreadsheet. (TxDOT 2007)

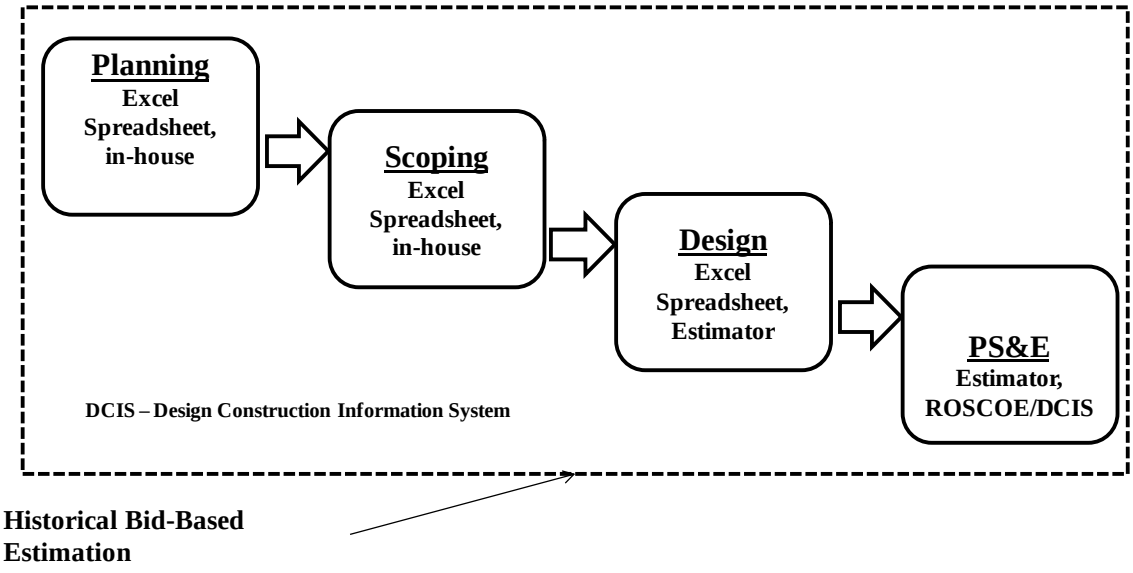



**Figure 65. TxDOT Estimation Framework.**

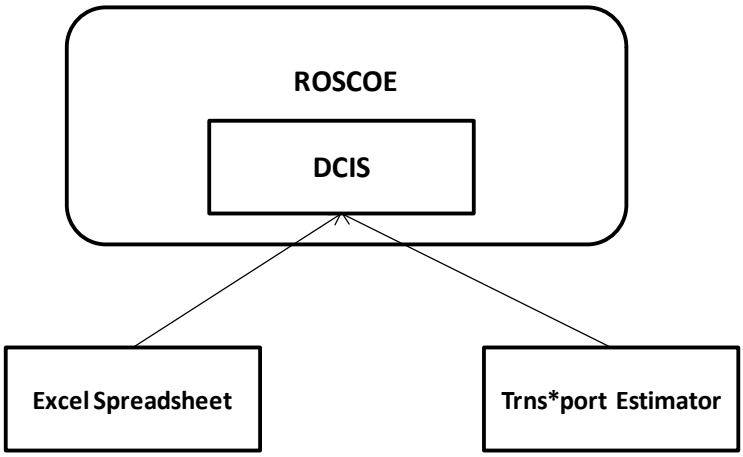



**Figure 66. Interaction between DCIS, Estimator, and Excel Spreadsheet.**

Acquiring Unit Cost Information

TxDOT uses DCIS to acquire all the bid details from the submitted low bids. The district offices use the average low bid information available on the TxDOT website in preparing the estimates. The three districts also review other bids to establish a range of prices used for each bid item. The unit costs can also be acquired from a Site Manager Spreadsheet available on their intranet (Crossroads). This spreadsheet provides the estimators with the current prices for each item of work along with their quantities for individual projects under construction.

The TxDOT website (http://www.dot.state.tx.us/services/design/estimator.htm) maintains the catalog of current historical unit prices, which is downloaded and used in Trns*port Estimator.

Storing Unit Cost Information

Historical unit costs are stored within DCIS. The database holds one month and twelve months moving averages available for each item of work. The historical unit

costs are stored as standard construction line items, and averages are available for the entire state and for each district within TxDOT.

Accessing Unit Cost Information

Districts use the one-month and twelve-month moving average available on their website at http://www.txdot.gov/business/avgd.htm as a source of historical unit costs. The website maintains the statewide moving average as well as moving averages for each district. Unit costs are also available for maintenance projects, again sorted based on district and the entire state (see Figures 67 and 68). Estimators also use bid data from similar projects currently under construction or recently completed when arriving at the unit cost.

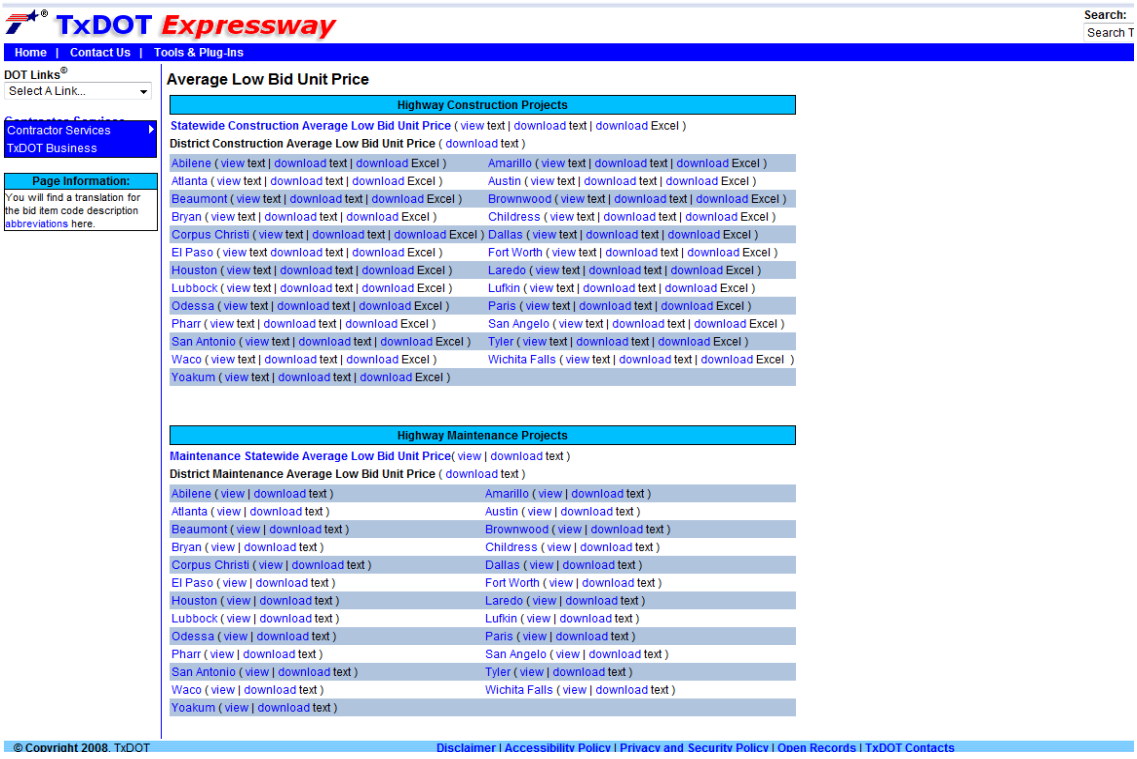



**Figure 67. TxDOT Average Low Bid Unit Price. (TXDOT 2008a)**

COMPUTER SECTION — TEXAS DEPARTMENT OF TRANSPORTATION — D19-C

AVERAGE LOW BID UNIT PRICES BY DISTRICT — PAGE 1

DISTRICT 18

| ITEM NO | DESCRIPTION | UNITS | JULY 31, 2008 QUANTITY | JULY 31, 2008 AVG BID | TWELVE-MONTH-MOVING QUANTITY | TWELVE-MONTH-MOVING AVG BID | TWELVE-MONTH-MOVING USAGE |
|---|---|---|---|---|---|---|---|
| 100 | SERIES | | | | | | |
| 100 2002 | PREPARING ROW | STA | 50.370 | 10.00000 | 2,127.860 | 12,860.47143 | 31 |
| 100 2003 | PREPARING ROW(TREE)(5" TO 12" DIA) | EA | | | 52.000 | 496.32385 | 2 |
| 104 2001 | REMOVING CONC (PAV) | SY | 2,717.000 | 6.00000 | 236,852.000 | 4.28109 | 18 |
| 104 2009 | REMOVING CONC (RIPRAP) | SY | 13.000 | 20.00000 | 4,475.500 | 9.52736 | 12 |
| 104 2011 | REMOVING CONC (MEDIANS) | SY | 437.060 | 6.00000 | 5,876.060 | 7.34767 | 9 |
| 104 2013 | REMOVING CONC (FOUNDATIONS) | SY | | | 611.000 | 12.54000 | 1 |
| 104 2015 | REMOVING CONC (SIDEWALKS) | SY | | | 6,590.670 | 6.72529 | 10 |
| 104 2017 | REMOVING CONC (DRIVEWAYS) | SY | 675.000 | 6.00000 | 22,204.740 | 7.49155 | 16 |
| 104 2021 | REMOVING CONC (CURB) | LF | | | 41,378.440 | 2.12157 | 10 |
| 104 2022 | REMOVING CONC (CURB AND GUTTER) | LF | | | 8,986.000 | 6.29114 | 4 |
| 104 2023 | REMOVING CONC (CTB) | LF | | | 1,106.000 | 10.14738 | 2 |
| 104 2024 | REMOVING CONC (RETAINING WALLS) | SY | | | 542.000 | 42.70849 | 3 |
| 104 2025 | REMOVE CONC (WINGWALL) | CY | | | 70.000 | 84.15000 | 1 |
| 104 2027 | REMOVING CONC (APPR SLAB) | SY | | | 360.000 | 8.00000 | 1 |
| 104 2028 | REMOVING CONC (MISC) | SY | | | 1,142.000 | 14.22329 | 4 |
| 104 2029 | REMOVING CONC (CURB OR CURB & GUTTER) | LF | | | 11.000 | 30.00000 | 1 |
| 104 2036 | REMOVING CONC (SIDEWALK OR RAMP) | SY | | | 1,042.400 | 6.50000 | 1 |
| 104 2037 | REMOVE CONC (RAIL) | LF | | | 385.000 | 18.51532 | 3 |
| 104 2040 | REMOVING CONC (PAVERS) | SY | | | 193.000 | 12.00000 | 1 |
| 105 2002 | REMOVING STAB BASE AND ASPH PAV (2") | SY | | | 4,395.000 | 3.59983 | 2 |
| 105 2008 | REMOVING STAB BASE AND ASPH PAV (6") | SY | | | 4,498.000 | 4.77679 | 4 |
| 105 2011 | REMOVING STAB BASE AND ASPH PAV (2"-6" | SY | | | 189,471.000 | 2.93451 | 4 |
| 105 2013 | REMOVING STAB BASE & ASPH PAV (9") | SY | | | 820.000 | 4.00000 | 1 |
| 105 2014 | REMOVING STAB BASE & ASPH PAV (7"-12") | SY | | | 28,837.000 | 2.82108 | 3 |
| 105 2015 | REMOVING STAB BASE & ASPH PAV (8"-10") | SY | 5,762.000 | 4.00000 | 50,669.000 | 3.90367 | 8 |
| 105 2021 | REMOVING STAB BASE AND ASPH PAV (0-4") | SY | | | 398.300 | 7.00000 | 1 |
| 105 2045 | REMOVING STAB BASE AND ASPH PAV (2"-8" | SY | | | 1,822.000 | 3.00000 | 1 |
| 105 2046 | REMOVING STAB BASE & ASPH PAV (0"-10") | SY | | | 2,642.000 | 3.34000 | 1 |
| 105 2052 | REMOVE STAB BASE & ASPH PAV (4"-5") | SY | | | 99,924.000 | 1.31000 | 1 |
| 105 2055 | REMOVING STAB BASE AND ASPH PAV(9"-14" | SY | 337.430 | 15.49999 | 18,599.430 | 5.68142 | 2 |
| 105 2059 | REMOVING STAB BASE & ASPH PAV(13"-18") | SY | 3,212.850 | 7.50000 | 42,957.850 | 5.64958 | 2 |
| 106 2001 | OBLITERATING ABANDONED ROAD | STA | 17.590 | 200.00000 | 24.500 | 574.36816 | 3 |
| 110 2001 | EXCAVATION (ROADWAY) | CY | 50,819.950 | 5.00000 | 797,696.700 | 5.66957 | 32 |
| 110 2002 | EXCAVATION (CHANNEL) | CY | | | 32,068.000 | 8.51726 | 10 |
| 112 2001 | SUBGRADE WIDENING (ORD COMP) | STA | | | 21.700 | 798.52304 | 2 |
| 132 2005 | EMBANKMENT (FINAL)(ORD COMP)(TY C) | CY | | | 1,935.000 | 21.33282 | 4 |
| 132 2006 | EMBANKMENT (FINAL)(DENS CONT)(TY C) | CY | | | 1,334,439.600 | 8.20882 | 25 |
| 132 2008 | EMBANKMENT (FINAL)(DENS CONT)(TY D) | CY | | | 60,703.000 | 1.00000 | 1 |
| 132 2025 | EMBANKMENT (FINAL) (DENS CONT) (TY C1) | CY | 3,933.280 | 5.00000 | 296,888.280 | 5.66757 | 3 |
| 132 2026 | EMBANKMENT (FINAL) (DENS CONT) (TY C2) | CY | 12,333.930 | 10.00000 | 507,794.930 | 5.13657 | 3 |
| 134 2001 | BACKFILL (TY A) | STA | | | 292.710 | 280.46394 | 3 |
| 134 2002 | BACKFILL (TY B) | STA | | | 320.210 | 104.32794 | 3 |

**Figure 68. TxDOT Average Low Bid Unit Prices for Dallas. (TXDOT 2008a)**

Estimators at the central office in Austin use a Site Manager spreadsheet to gather the latest unit prices on active projects. District estimators can use this spreadsheet to compare unit prices derived from other sources. The spreadsheet titled '***Item Search by Nbr Desc or SupplDesc***' is available under the Contract Administration section within Crossroads. Estimators are given an option to search items of work based on item number, description, and supplemental description. Figures 69, 70, and 71 provide the results for the three search options. Knowledge of this spreadsheet is not widely known within TxDOT.

SiteManager Item Search by Description  Report Date: 09/19/2008

Description Queried: FLEX BASE

| District | Area Office No. | County | CSJ | Project No. | Contract No. | Letting Date | Cont Status | Spec Yr | Line No. | Item Code | SP | Item Description | Orig Bid Qty | CO Item QTY | Total Bid QTY (N+O) | Bid Price | Qty Installed to Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WICHITA FALLS | 051 | COOKE | 004501049 | NH 2005(138) | 01053020 | 20050111 | CMPL | 1993 | 0090 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 3.00 | 0.000 | 3.00 | $ 1,000.00 | 0.000 |
| HOUSTON | 061 | FORT BEND | 018802037 | NH 2004(399) | 05043224 | 20040512 | ACTV | 1993 | 0125 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 322.00 | 0.000 | 322.00 | $ 100.00 | 322.000 |
| HOUSTON | 061 | FORT BEND | 054303057 | CPM 543-3-57 | 01043208 | 20040109 | ACTV | 1993 | 0065 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 688.00 | (688.000) | 0.00 | $ 110.00 | 0.000 |
| HOUSTON | 061 | FORT BEND | 141502036 | STP 2004(706) | 09043224 | 20040910 | ACTV | 1993 | 0085 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 2.24 | 0.000 | 2.24 | $ 1,350.00 | 0.000 |
| HOUSTON | 061 | FORT BEND | 168301031 | STP 2004(89) | 12033015 | 20031204 | ACTV | 1993 | 0095 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 61.99 | 0.000 | 61.99 | $ 125.00 | 61.990 |
| HOUSTON | 061 | FORT BEND | 168506027 | STP 2004(186) | 01043021 | 20040108 | ACTV | 1993 | 0110 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 60.00 | (60.000) | 0.00 | $ 162.30 | 0.000 |
| HOUSTON | 061 | FORT BEND | 168506027 | STP 2004(186) | 01043021 | 20040108 | ACTV | 1993 | 0111 | 01340507 | | BACKFILL (TY A)(FLEX BASE) | 0.00 | 242.000 | 242.00 | $ 296.59 | 242.000 |
| HOUSTON | 061 | FORT BEND | 196502006 | STP 2004(735) | 10043208 | 20041015 | ACTV | 1993 | 0100 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 4.84 | 0.000 | 4.84 | $ 725.00 | 4.840 |
| BRYAN | 053 | ROBERTSON | 004906072 | CPM 49-6-72 | 10043227 | 20041015 | ACTV | 1993 | 0080 | 01340507 | 000 | BACKFILL (TY A)(FLEX BASE) | 55.68 | 0.000 | 55.68 | $ 320.00 | 55.680 |
| PHARR | 053 | HIDALGO | 086501066 | STP 2004(176)MI | 01043010 | 20040108 | ACTV | 1995 | 0115 | 02475241 | 009 | FLEX BASE (RDWY DEL)(TY D GR | 9,826.50 | 0.000 | 9,826.50 | $ 17.87 | 9,826.500 |
| PHARR | 053 | HIDALGO | 086501083 | STP 2004(512)MI | 10043204 | 20041015 | ACTV | 1995 | 0130 | 02475241 | 009 | FLEX BASE (RDWY DEL)(TY D GR | 14,336.00 | 0.000 | 14,336.00 | $ 20.50 | 12,912.289 |
| LUFKIN | 053 | ANGELINA | 116501022 | STP 2008(671)HE | 08083018 | 20080610 | ACTV | 2004 | 0125 | 04002010 | 004 | CUT & RESTORING PAV (FLEX BA | 228.00 | 0.000 | 228.00 | $ 20.00 | 168.000 |
| YOAKUM | 057 | AUSTIN | 024001021 | BR 2009(044) | 09083005 | 20080909 | PEND | 2004 | 0690 | 04002010 | 004 | CUT & RESTORING PAV (FLEX BA | 31.00 | 0.000 | 31.00 | $ 85.00 | 0.000 |
| YOAKUM | 057 | AUSTIN | 027108016 | STP 2008(432) | 03083219 | 20080305 | ACTV | 2004 | 0175 | 04002010 | 004 | CUT & RESTORING PAV (FLEX BA | 104.00 | 0.000 | 104.00 | $ 34.00 | 121.000 |
| AUSTIN | 050 | CALDWELL | 011503022 | STP 2008(474) | 04083226 | 20080409 | ACTV | 2004 | 0105 | 04002010 | 000 | CUT & RESTORING PAV (FLEX BA | 177.00 | 0.000 | 177.00 | $ 26.00 | 0.000 |
| DALLAS | 059 | ELLIS | 104801020 | SFT 1048-1-20 | 06063032 | 20060608 | ACTV | 2004 | 0167 | 04002010 | | CUT & RESTORING PAV (FLEX BA | 0.00 | 177.300 | 177.30 | $ 34.00 | 177.300 |
| YOAKUM | 058 | GONZALES | 021604011 | SFT 216-4-11 | 08063252 | 20060809 | ACTV | 2004 | 0070 | 04002010 | 004 | CUT & RESTORING PAV (FLEX BA | 134.70 | 0.000 | 134.70 | $ 85.00 | 134.700 |
| YOAKUM | 058 | GONZALES | 021604011 | SFT 216-4-11 | 08063252 | 20060809 | ACTV | 2004 | 0605 | 04002010 | 004 | CUT & RESTORING PAV (FLEX BA | 242.00 | 0.000 | 242.00 | $ 85.00 | 168.000 |

**Figure 69. Item Search by Description - Site Manager Spreadsheet. (TXDOT 2008a)**

SiteManager Item Search by Number  Date Report: 09/19/2008

Item Nbr Queried: 03162399

| District | Area Office No. | County | CSJ | Project No. | Contract No. | Letting Date | Cont Status | Spec Yr | Line No. | Item Code | SP | Item Description | Orig Bid Qty | CO Item QTY | Total Bid QTY (N+O) | Bid Price | Qty Installed to Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ABILENE | 051 | TAYLOR | 000606090 | IM 0202(221) | 07073017 | 20070710 | ACTV | 2004 | 0100 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 47,170.000 | 0.000 | 47,170.000 | $ 2.65 | 47,705.000 |
| ABILENE | 051 | TAYLOR | 000618044 | HP 2007(669) | 07073203 | 20070711 | ACTV | 2004 | 0195 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 32,154.000 | 0.000 | 32,154.000 | $ 3.00 | 540.000 |
| ABILENE | 051 | TAYLOR | 003401118 | STP 2007(752) | 08073220 | 20070808 | ACTV | 2004 | 0095 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 8,696.000 | 0.000 | 8,696.000 | $ 3.50 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 0135 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,676.000 | 0.000 | 1,676.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 0670 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,894.000 | 0.000 | 1,894.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 1175 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,842.000 | 0.000 | 1,842.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 1690 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,717.000 | 0.000 | 1,717.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 2240 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,581.000 | 0.000 | 1,581.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 2840 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,598.000 | 0.000 | 1,598.000 | $ 3.75 | 0.000 |
| ABILENE | 051 | TAYLOR | 005401022 | BR 2008(467) | 02083204 | 20080208 | ACTV | 2004 | 3410 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 1,600.000 | 0.000 | 1,600.000 | $ 3.75 | 0.000 |
| AUSTIN | 050 | BASTROP | 026513004 | BR 2007(627) | 08073205 | 20070808 | ACTV | 2004 | 0145 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 2,274.000 | 0.000 | 2,274.000 | $ 5.00 | 0.000 |
| AUSTIN | 050 | BASTROP | 114902017 | BR 2008(816) | 08083220 | 20080808 | ACTV | 2004 | 0105 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 5,756.000 | 0.000 | 5,756.000 | $ 5.20 | 0.000 |
| AUSTIN | 050 | LEE | 021102022 | BR 2007(671) | 07073227 | 20070711 | ACTV | 2004 | 0125 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 26,762.000 | 0.000 | 26,762.000 | $ 3.00 | 4,362.000 |
| AUSTIN | 050 | LEE | 047302031 | STP 2007(787)HE | 08073222 | 20070808 | ACTV | 2004 | 0110 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 30,376.000 | 0.000 | 30,376.000 | $ 3.20 | 28,695.000 |
| AUSTIN | 050 | LEE | 047302031 | STP 2007(787)HE | 08073222 | 20070808 | ACTV | 2004 | 0535 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 5,274.000 | 0.000 | 5,274.000 | $ 3.20 | 4,700.000 |
| BRYAN | 050 | BRAZOS | 064004081 | STP 2009(016) | 09083207 | 20080910 | PEND | 2004 | 0070 | 03162399 | 000 | ASPH (AC-20-5TR OR AC-12-5TR) | 14,069.000 | 0.000 | 14,069.000 | $ 4.70 | 0.000 |

**Figure 70. Item Search by Number - Site Manager Spreadsheet. (TXDOT 2008a)**

SiteManager Item Search by Description  Report Date: 09/19/2008

Description Queried: COMPU

*Tip: Enter description using UPPER CASE, lower case, and Sentence Case for a complete search. Only one entry may be made at a time.*

| District | Area Office No. | County | CSJ | Project No. | Contract No. | Letting Date | Cont Status | Spec Yr | Line No. | Item Code | SP | Item Description | Supplemental Description 1 | Orig Bid Qty | CO Item QTY | Total Bid QTY (N+O) | Bid Price | Qty Installed to Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EL PASO | 051 | HUDSPETH | 000205039 | IM 10-1(226) | 01003002 | 20000104 | ACTV | 1995 | 5769 | 54095001 | | COMPUTER EQUIP (DESKTO | CONTRACTOR INSTALLATIOI | 0.00 | 1.000 | 1.00 | $ 6,890.87 | 1.000 |
| EL PASO | 051 | HUDSPETH | 000207038 | MG 2001(188) | 01013002 | 20010103 | CMPL | 1995 | 5769 | 54095001 | | COMPUTER EQUIP (DESKTO | INSTALLATION OF COMPUTE | 0.00 | 1.000 | 1.00 | $ 7,289.87 | 1.000 |
| EL PASO | 051 | HUDSPETH | 000205039 | IM 10-1(226) | 01003002 | 20000104 | ACTV | 1995 | 5770 | 54095002 | | COMPUTER EQUIP (PRINTEF | CONTRACTOR INSTALLATIOI | 0.00 | 1.000 | 1.00 | $ 948.98 | 1.000 |
| EL PASO | 051 | HUDSPETH | 000207038 | MG 2001(188) | 01013002 | 20010103 | CMPL | 1995 | 5770 | 54095002 | | COMPUTER EQUIP (PRINTEF | INSTALLATION OF PRINTER I | 0.00 | 1.000 | 1.00 | $ 948.98 | 1.000 |
| EL PASO | 052 | EL PASO | 092406245 | C 924-6-245 | 12043012 | 20041207 | ACTV | 1993 | 0400 | 96040501 | 000 | CONTRACTOR FORCE ACCO | COMPUTER EQUIPMENT | 1,000.00 | 0.000 | 1,000.00 | $ 1.00 | 0.000 |
| EL PASO | 051 | EL PASO | 092406257 | ITS 2004(802) | 12053011 | 20051201 | ACTV | 2004 | 0200 | 96062001 | 000 | FORCE ACCOUNT ID 1 | EL PASO-COMPUTER EQUIPI | 8,610.00 | 0.000 | 8,610.00 | $ 1.00 | 0.000 |
| EL PASO | 051 | EL PASO | 092406257 | ITS 2004(802) | 12053011 | 20051201 | ACTV | 2004 | 0460 | 96062002 | 000 | FORCE ACCOUNT ID 2 | ODESSA COMPUTER EQUIPM | 8,610.00 | 0.000 | 8,610.00 | $ 1.00 | 0.000 |
| AUSTIN | 050 | CALDWELL | 091422044 | BR 2001(830) | 11033225 | 20021108 | CMPL | 1993 | 0335 | 96080501 | | UNIQUE CHANGE ORDER ITI | COMPUTER & PRINTER RENT | 0.00 | 4.000 | 4.00 | $ 25.00 | 4.000 |
| AMARILLO | 050 | POTTER | 004201027 | NH 2004(12) | 11033204 | 20031105 | ACTV | 1993 | 0405 | 96080501 | | UNIQUE CHANGE ORDER ITI | COMPUTER, PHONE & SUPP | 0.00 | 1.000 | 1.00 | $ 2,784.00 | 1.000 |
| AMARILLO | 050 | POTTER | 263504014 | STP 2002(763) | 10033209 | 20031009 | ACTV | 1993 | 0666 | 96080501 | | UNIQUE CHANGE ORDER ITI | ADDITION OF COMPUTER, PO | 0.00 | 1.000 | 1.00 | $ 1,921.65 | 1.000 |
| BEAUMONT | 053 | NEWTON | 030502038 | MG 2001(254) | 02013067 | 20010207 | CMPL | 1993 | 0960 | 96080503 | | UNIQUE CHANGE ORDER ITI | COMPUTER EQUIPMENT FOR | 0.00 | 1.000 | 1.00 | $ 1,972.55 | 1.000 |
| SAN ANTONIO | 055 | WILSON | 014303024 | NH 2000(456) | 06003059 | 20000607 | CMPL | 1993 | 0645 | 96080508 | | UNIQUE CHANGE ORDER ITI | COMPUTER & SET UP | 0.00 | 1.000 | 1.00 | $ 2,960.99 | 0.000 |
| SAN ANTONIO | 055 | WILSON | 014303024 | NH 2000(456) | 06003059 | 20000607 | CMPL | 1993 | 645 | 96080509 | | UNIQUE CHANGE ORDER ITI | COMPUTER PRINTER | 0.00 | 1.000 | 1.00 | $ 276.12 | 0.000 |
| SAN ANTONIO | 055 | WILSON | 014303024 | NH 2000(456) | 06003059 | 20000607 | CMPL | 1993 | 0647 | 96080510 | | UNIQUE CHANGE ORDER ITI | COMPUTER SOFTWARE | 0.00 | 1.000 | 1.00 | $ 1,057.20 | 0.000 |
| FORT WORTH | 054 | TARRANT | 017201035 | NH 2002(36) | 08023006 | 20020806 | CMPL | 1993 | 1035 | 96080514 | | UNIQUE CHANGE ORDER ITI | PURCHASE & SETUP OF ITEI | 0.00 | 1.000 | 1.00 | $ 294.26 | 1.000 |
| AUSTIN | 098 | TRAVIS | 313601138 | TTA 2005(103) | 10043401 | 20041015 | ACTV | 1993 | 0076 | 96080514 | 000 | UNIQUE CHANGE ORDER ITI | CO #13 MODIFICATION TO HV | 0.00 | 1.000 | 1.00 | $ 28,606.30 | 1.000 |
| SAN ANTONIO | 058 | BEXAR | 052104190 | NH 2005(136) | 01053201 | 20050112 | ACTV | 1993 | 1467 | 96080526 | | UNIQUE CHANGE ORDER ITI | COMPUTER ROOM TERMINA | 0.00 | 2.000 | 2.00 | $ 1,368.68 | 2.000 |

**Figure 71. Item Search by Supplemental Description - Site Manager Spreadsheet. (TXDOT 2008a)**

Using the filter option available within Excel, users can change the search results to suit their requirements. For example, the estimator is estimating the unit price of 200 square yards of Flex Base. By searching for Flex Base in this Excel spreadsheet (either by Item Number or Description search) and setting the filter on 'Total Bid Qty' column to show only quantities within a certain range of 200 square yards, the estimator can check unit prices against current price (see Figure 71).

In addition to using one-month and twelve-month moving averages, estimators also look at the bid tabulation details for all the projects (See Figure 72). This helps the estimator assess the price used by four low bidders for the project and identify the range of bids submitted by the contractors. Bid tabulations and bid totals are maintained under Contract Letting section within the Construction Division (http://www.dot.state.tx.us/

TxDOT Expressway

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**Tabulation of Bids for Project STP 2008(683)RGS**

Last Update: Tuesday, September 9, 2008

Text version of this page

**County:** BRAZOS
**Type:** CONST RAILROAD GRADE SEPARATION STR
**Time:** 413 WORKING DAYS
**Highway:** FM 2818
**Length:** 5.646
**Limits:**
**From:** AT UPRR IN COLLEGE STATION
**To:** DOT NO. 743219D

**Let Date:** 09/09/08
**Seq No:** 3001
**Project ID:** STP 2008(683)RGS
**Contract #:** 09083001
**CCSJ:** 2399-01-022
**Check:** $100,000.00
**Misc Cost:** $327,916.00

| Estimate | $23,268,621.45 | % Over/Under | Company |
|---|---|---|---|
| Bidder 1 | $20,854,415.32 | -10.38% | KNIFE RIVER CORPORATION - SOUTH |
| Bidder 2 | $22,784,360.69 | -2.08% | W.W. WEBBER, LLC |
| Bidder 3 | $25,931,271.22 | +11.44% | BIG CREEK CONSTRUCTION, LTD. |
| Bidder 4 | $26,751,463.02 | +14.97% | A. L. HELMCAMP, INC. |

| Item Code | Description | Unit | Quantity | Unit Est. | Bidder | Unit Bid |
|---|---|---|---|---|---|---|
| 1002002002 | PREPARING ROW | STA | 88.800 | 3000.00 | 1<br>2<br>3<br>4 | 2500.000<br>1918.000<br>5000.000<br>4000.000 |
| 1042011 | REMOVING CONC (MEDIANS) | SY | 198.000 | 45.00 | 1<br>2<br>3<br>4 | 15.000<br>12.000<br>10.000<br>30.000 |
| 1042022 | REMOVING CONC (CURB AND GUTTER) | LF | 2429.000 | 7.00 | 1<br>2<br>3<br>4 | 2.800<br>5.000<br>10.000<br>10.000 |
| 1052008 | REMOVING STAB BASE AND ASPH PAV (6") | SY | 9144.000 | 5.00 | 1<br>2<br>3<br>4 | 3.000<br>4.000<br>2.640<br>5.000 |
| 1052058 | REMOVING STAB BASE & ASPH PAV (10" - 12" | SY | 2286.000 | 7.00 | 1<br>2<br>3<br>4 | 3.600<br>5.000<br>7.930<br>9.000 |
| 1102001 | EXCAVATION (ROADWAY) | CY | 141136.000 | 5.50 | 1<br>2<br>3<br>4 | 0.000<br>0.000<br>3.000<br>6.000 |
| 1322004 | EMBANKMENT (FINAL) (DENS | CY | 187971.000 | 8.00 | 1 | 0.000 |

**Figure 72. TxDOT Bid Tabulations. (TXDOT 2008b)**

business/bt.htm). Bid information is divided into construction, maintenance and local let projects. Figure 72 shows sample bid tabulation from a recently let construction project.

Applying Unit Cost Information

TxDOT uses one-month and twelve-month moving averages based on low bids for establishing unit prices. Sometimes a three-month moving average is also considered for greater understanding of the prices. The use of twelve-month moving averages evens out the effect of using only the low bid. Weighted moving averages, used in determining

the unit prices, are preferred over simple averages since they take into consideration the effect of quantities when arriving at the unit price. Some of the important factors influencing the unit prices are location of the project and quantity. Though there is no process guidance on how to adjust unit prices for quantities, a general rule of thumb often followed is the higher the quantity, the lower would be the unit price, but up until a point. Cost estimates are updated on a yearly basis. For example, if four percent annual inflation is considered and the project is five years away from letting, then add 20 percent inflation to the estimates. For items having no historical data or that are unique to a project, prices are established by contacting suppliers and contractors, looking at the statewide and maintenance averages or by contacting adjoining districts. Estimators prefer not to refer to the catalog unit prices for hot mix asphalt, cement, and steel because of their high volatility in recent times. Adjustments to unit prices are completely based on the experience and engineering judgment of the estimators. In its PS&E Preparation manual, TxDOT maintains a list of factors to be considered when adjusting unit bid prices but does not provide the quantitative factors to be used when making the adjustments. Following are the factors outlined in the manual to be considered when adjusting unit prices:

- Project size
- Project location
- Traffic conditions
- Construction season
- Accessibility

- Restrictive conditions
- Availability of materials
- Specifications
- Construction time
- Plan clarity
- Bidder competition

## SUMMARY OF RESULTS

The results from the analysis of survey results and responses from the interviews showed the following pattern among state agencies with respect to unit cost development.

- Historical bid based estimating is still preferred form of estimating for almost all the agencies.
- Cost Based Estimating is used only for preparing Engineers Estimate by very few agencies (VDOT, MnDOT).
- Most state agencies rely on Excel Spreadsheet to prepare Planning and Scoping Level Estimates.
- Agencies like FDOT, Caltrans, and VDOT have devised their own system to compute preliminary estimate based on Cost-Per-Mile values of typical sections.
- Sophisticated systems like Trns*port CES, Estimator and PDBS are used for developing the final Engineers Estimate.

- Few agencies like FDOT and Caltrans have their historical bid data based on market area.
- The preferred form of storing historical bid data in order of their preference:
  - Standard Construction Line Item
  - Project Types
  - Work Categories
- Agencies like WsDOT, Caltrans, and UDOT use sophisticated systems for accessing their unit cost database which is capable of generating customized reports.
- The preferred statistical technique to apply on historical data in order of their preference:
  - Weighted Average
  - Simple Average
  - Scatter Plot with best fit
- Agencies like UDOT and TxDOT use moving averages (One month and Twelve months) for determining unit prices for items showing fluctuations in their prices.

These patterns and approaches to unit cost development, along with the information obtained through the literature review, provide essential foundation for building the unit cost development framework.

# CHAPTER VI

# UNIT COST DEVELOPMENT FRAMEWORK

The research aims to standardize the unit cost development approach by defining a framework based on results from the study. Similar to the survey, the framework is again divided into five sections to address different aspects of construction unit cost information. The framework outlines the characteristics of the unit cost information required for estimating at various phases of project. Figure 73 shows the proposed framework along with the interaction among these sections and the historical database.

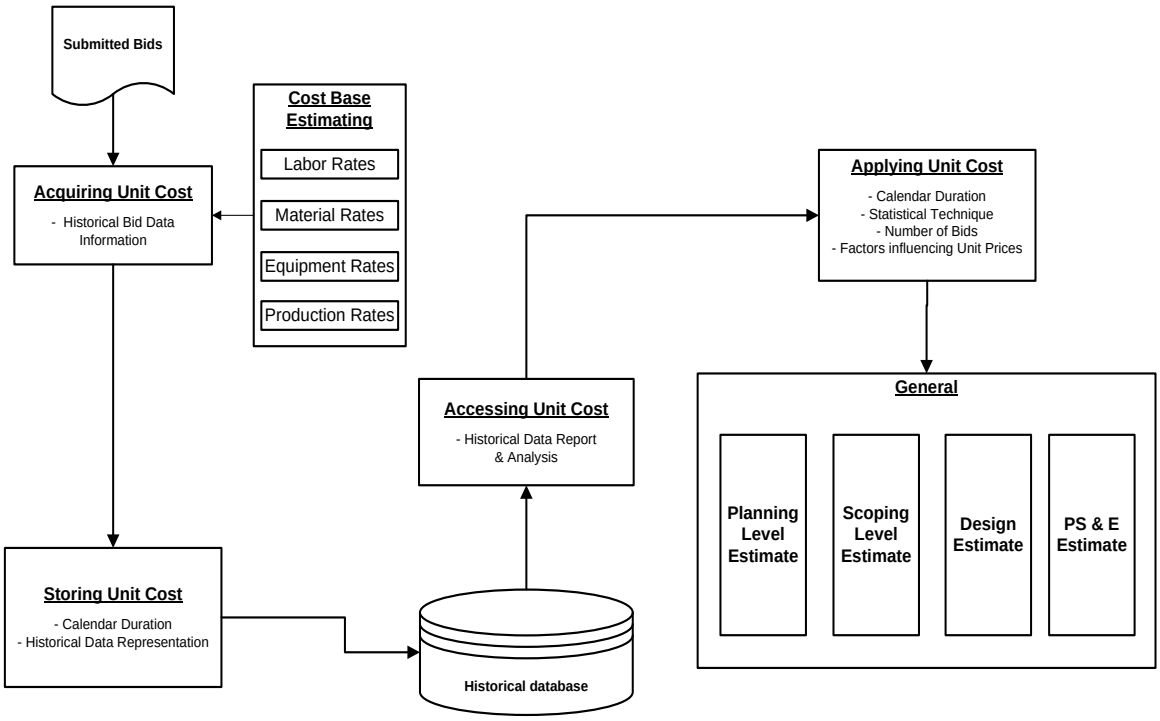


**Figure 73. Unit Cost Development Framework.**

The estimating technique used in the above four project development phases is governed by the amount of project information available. At the planning phase, the details of the project are very limited. Estimates are prepared using a Cost per Mile (CPM) approach or by similar project estimating. In the scoping phase, the estimators determine the approximate quantities of major items of work (e.g. pavements, bridges, right-of-way) and perform historical bid based estimating or parametric estimating for preparing the scoping level estimate. Once in the design phase, the exact quantity of most of the items of work is established. Estimates are prepared using the bid based approach as project requirements become clearer. At the final phase, the work items and their associated quantities are finalized. Using a combination of bid based estimating and cost based estimating, the final Engineer's Estimate is prepared. This is where the labor rates, material rates, equipment rates, and production rates are utilized. Table 11 summarizes the estimating techniques used in different phases of project development.

**Table 11. General Information – Unit Cost Development Framework.**

| **Project Phases** | **Estimating Techniques** |
|---|---|
| Planning | Similar project<br>Cost-per-Mile approach |
| Scoping | Parametric Estimating<br>Historical Bid Based Estimating |
| Design | Historical Bid Based Estimating |
| PS&E | Cost Based Estimating<br>Historical Bid Based Estimating |

In essence, the estimating technique is governed by the project information present at the time of estimation. The choice of estimating technique influences the way historical unit cost information is used. Using the framework defined in Figure 72, a systematic approach to represent historical unit cost information for the four project phases is explained below. Since the primary estimation techniques for the scoping phase, the design phase, and the PS&E phase are the same, the unit cost development framework would be similar in structure.

## UNIT COST DEVELOPMENT FRAMEWORK – PLANNING PHASE

The input to the framework comes in the form of submitted bids from all previous projects. The first step in unit cost development is to acquire information from the submitted bids.

### Acquiring Unit Cost Information

At this phase, the project information is limited. Hence the amount of information that is needed to perform estimation is also limited. The following are the essential details required from each project submitted into the bid management system. The details include all the project information and the awarded bids for the project. This information is important for building estimating systems that utilizes CPM estimation.

- Project station information
- Construction length
- Location (rural/urban)

- Total project cost
- Project description (type of project)
- All awarded bid items
- Year of construction

**Storing Construction Unit Cost Information**

Once the project information and the awarded bid information are obtained, they need to be stored in the database with suitable identifiers to build a system for CPM estimating. Of the three estimating techniques used at this phase, cost per lane mile involves more identifiers to be used when storing historical bid data. While estimating by similar project approach requires only one identifier which essentially would be the project description (type of project).

Historical Data Representation – Identifiers

The purpose of the identifier is to enable the grouping of bid details under major categories of work. The identifiers include pavements, bridges, right-of-way, and utilities. This should be performed for all the bid items submitted for each project. In addition to grouping them, they need to be linked to an identifier that defines the type of project in which they were used. For example, project identifier could be a description like “Two lane reconstruction or new (40’ wide) –Rural”. This step is crucial as the effectiveness of the CPM approach is dependent on how accurately this information is grouped when storing into the historical database.

Calendar Duration

The CPM system needs to be updated regularly by using historical bid data from the past one or two years of letting.

**Accessing Unit Cost Information**

When the historical bid data is properly stored in the database with the suitable identifiers, accessing these data becomes easier for the reporting system.

Historical Data Report

For accessing the historical data needed for estimation, a system capable of generating the total cost per mile averages for each work categories in a project needs to be in place. This step has to be performed for all the projects let in the state. Projects with similar scope would then have to be grouped together. Then averages for each work categories need to be taken for various project types identified. This would provide the estimator with the statewide averages for major categories of work by different project types.

**Applying Unit Cost Information**

For preparing the construction estimate, all that the estimator needs to do is to select the project type (project description identifier) matching in scope and compute the total cost based on the CPM value and the project length. The estimate then needs to be adjusted for inflation, preliminary engineering (PE), and construction engineering (CE). Since substantial information (design, site conditions) about the project is unknown at this phase, high contingency needs to be added to cover the uncertainties. These adjustments are typically a certain percentage of the construction estimate. The

percentages are chosen based on the experience and engineering judgment of the estimator. The contingency percentage generally ranges from 25% to 40%. The planning level estimate is then a combination of the construction estimate, inflation, PE cost, CE cost, and contingency. Figure 74 summarizes the unit cost development framework for planning phase.

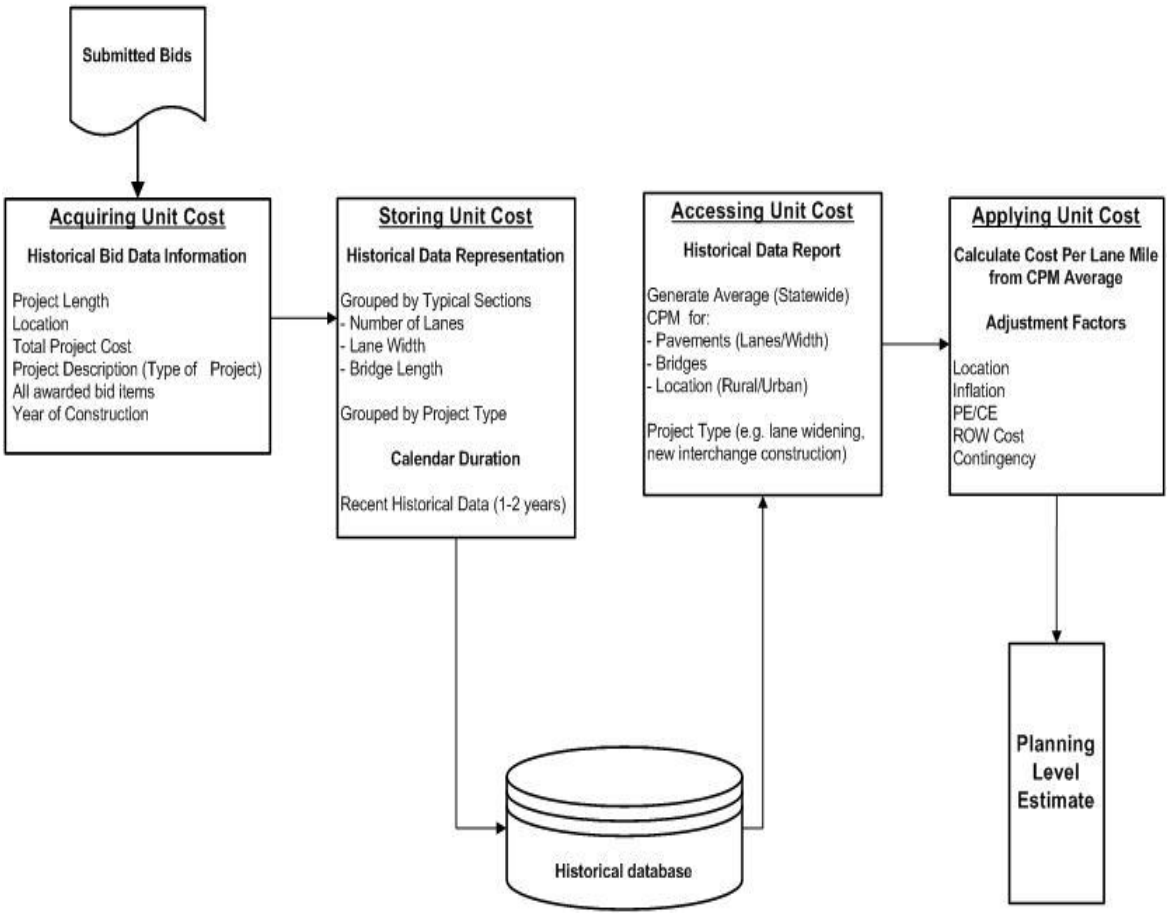


**Figure 74. Unit Cost Development Framework – Planning Phase.**

## UNIT COST DEVELOPMENT FRAMEWORK – SCOPING/DESIGN/PS&E PHASES

The framework for the remaining phases differs from the planning level framework because of the different estimating approach used in these phases. Thus the representation and usage of historical bid data is different from the historical data used in the planning level estimate. The following section explains the combined unit cost development framework for preparing the scoping level estimate, design estimate, and the final Engineer's Estimate.

### Acquiring Unit Cost Information

The input to this framework is the same historical bid data used in the previous framework. The same set of information that is captured during the planning phase is used in this framework as well. The difference in this framework is that instead of using just the information from the awarded bid, information from all the bids is considered for use in this framework. In addition, it is essential to also acquire information on labor rates, equipment rates, material rates, and production rates periodically. These rates would be important when cost based estimating is used for preparing final Engineer's Estimate. Table 12 summarizes the information that needs to be acquired for performing bid based estimating and cost based estimating.

**Table 12. Unit Cost Development Framework – Acquiring Unit Cost Information.**

| **Historical Bid Based Estimating** | |
|---|---|
| • Project station information,<br>• Construction length,<br>• Location,<br>• Total project cost,<br>• Project description (Type of project),<br>• Bid item number,<br>• Item description, | • Item quantity,<br>• Unit of work,<br>• Letting date,<br>• All submitted bid amount, and<br>• Year of construction |
| **Cost Based Estimating** | |
| • Equipment rates,<br>• Labor rates,<br>• Material rates, and<br>• Production rates | |

The rationale behind using this information is to provide all the required details to the estimator to help the estimator make informed decisions. By providing all the bid amounts for each item of work, the estimator can check for any unbalancing of bids or to obtain a general price range for an item of work. By listing the quantities, the estimators could perform weighted average to determine the unit price. The labor rates, equipment rates, material rates, and production rates are used while preparing the final Engineer's Estimate using the cost based estimating technique.

**Storing Unit Cost Information**

While storing unit cost, some of the identifiers like project type and work categories will also be used here in this framework. In addition, the historical bid data

would also need to be stored as standard construction line item. These data should be represented by state, districts, market areas, units of work, and funding source.

Calendar Duration

The database typically stores many years of historical data and most of them become outdated. For estimation purpose, the historical data from the past one or two years of letting should be available for performing estimation. This duration would provide current rates and enough data to perform analysis for determining unit costs.

**Accessing Unit Cost Information**

Accessing unit cost is all about providing a flexible search and reporting option to the estimators. The representation of historical data in a format desired by the estimators is essential for preparing accurate estimates. Information systems with reporting and analysis capabilities will reduce the time spent searching for unit cost details. By providing for analysis of search results, the estimators could perform the required statistical analysis for determining the unit costs.

Historical Data Report

The following would be the essential information that is needed by the estimators to determine the unit costs for each item of work.

- Bid item number or description,
- Regions/Districts
- Quantity estimated
- Submitted bids: Low, Two Low, Three Low, and All Bids
- Year of letting

- Unit of Measurement

Information like the quantities estimated and the submitted bids allow the estimator to look at the price range for each item of work and also study the effect of quantities on total price. Further by providing the location information, prices specific to the project location can be identified. By giving an option to choose the type of bids, the estimator could just see the low bid for an item, or can review the three low bids, or all the bids for an item. Unit of measurement defines the unit by which that particular work item was paid and the year of letting allows the estimator to decide on a suitable inflation factor. The purpose of having this information is to provide the flexibility in analyzing unit costs when applying them.

Analyses of Historical Data Capability

The following are some of the analysis that could be performed using the above information. The purpose of these analyses is to aid estimators in their estimation process.

- Regression Analysis – It is a statistical technique used in estimating the unit price of a particular item of work based on quantities installed. By forming a regression equation between the quantity and unit price obtained from the historical data, unit price of the quantity to be installed can be estimated. E.g. estimating the average low bid price based on the quantity.
- Trend Analysis – This is a graphical report showing the fluctuation of the unit price over a period of time. E.g. simple graphs showing the trend of average price of particular work category.

- Weighted Average/Moving Average Report – Weighted average unit price is the average unit price after it has been adjusted for the quantities. Moving average is the average price of a work item for a defined period of time. The typical values for the duration are one month, three months, and twelve months. E.g. reporting weighted average for a particular item of work or generating 12 months moving average for a work category.

**Applying Unit Cost Information**

Once the list of quantities and items are obtained, the historical data is accessed to determine the unit cost. Before determining the unit cost, the calendar duration, statistical techniques, and adjustment factors need to be defined for applying unit cost information.

Calendar Duration

Generally the duration over which the historical data is accessed varies from item to item. Items that are frequently used (e.g. asphalt for pavements), historical data from last three to six months could be considered for determining unit cost. For other items, seven to twelve months of historical data could be considered. If the duration does not provide enough data for analysis, higher duration (one to two years) of historical data could be considered.

The advantage of using three to six months of historical data is that it provides the most current rates for an item. It also helps if the project is going to be let immediately. But this approach would fail to capture sudden momentary rises in prices resulting from heavy demand for that item. This would result in estimating the project

higher than its actual amount. Another problem of having shorter duration is there might not be enough data to perform analysis upon. Then it becomes essential to increase the duration to accommodate sufficient data points for analysis. Typically a minimum of 10 data points are required for taking averages and 15 data points for performing regression analysis.

Statistical Techniques

Statistical techniques such as weighted average, regression analysis, and simple average for only minor items of work should be applied when determining the unit price. These techniques can be applied to both major and minor items of work, subject to availability of sufficient data (15 data points for regression and 10 for simple average) for analysis. For major items of work showing fluctuations in its prices, moving average (weighted) is preferred. The duration for taking moving average could be three months and one year. The purpose of taking the weighted average is for negating the effect of economy of scale resulting from having large quantities of one item. By considering the two durations for moving average, estimator would be able to spot any changes in the prices in the last month from the yearly average. This would help the estimator get a better understanding of the price fluctuation and make the decision process easier.

Number of Bids

Three low bids, as found from the literature, are recommended to be used in determining the unit price to get better results. By using three low bids, the effect of unbalanced prices can be removed. Unbalanced prices used by a single bidder can skew

up or down the individual item average in the database. Though other bid prices could also be referred in order to know the price range used by all the contractors.

Adjustment Factors

The unit prices obtained from analysis of historical bid data need to be adjusted based on the following factors.

- Location – The location of the project from the location of source of materials can affect the unit price accordingly. The farther the distance of material source to the project location, longer would be the haul distance. This would increase the cost involved in transporting the material to the project. As a result the contractors tend to increase their unit price.
- Quantity – Large quantities of particular material would tend to reduce unit prices (economy of scale). On the other hand, if there is a heavy demand for that material due to a lot construction activity near the project location, the unit prices will tend to increase.
- Constructability – If there is any difficult construction involved, which the contractor is not experienced in, the unit prices would increase.
- Scheduling/Lead Time – Contractors tend to increase their prices if the schedule does not provide any lead time for the contractors to move their crews and equipments.
- Availability of Items – Items that are in high demand or scarce are likely to cost more.

- Lump Sum Items – Contractors take on extra risk due to the use of lump sum items and as a result increase their unit price to counter the risk.
- Competition/Contractor Availability – a project which is let late in the year, when the contractors have already scheduled their work for the year, are more likely to experience higher bid prices.
- Specialty Work – Projects having first time used items or specialty items have to be adjusted for contractor lack of experience and potential risk involved. As a result, contractors are likely to increase their unit prices.

In order to standardize the adjustments of unit cost information and project estimates, a checklist shown in Table 13 could be helpful. The checklist aids the estimators to identify the factors affecting the estimate and red flag those items. By red flagging the items, estimators would be aware of the factors for which the unit prices need to be adjusted and provide suitable mark-ups. This needs to be performed whenever the project estimates are prepared during the Design and PS&E phase as all the design and location information about the project would become available. Though this is a time consuming process, it is an important step in applying unit cost information. Figure 75 summarizes the unit cost development framework discussion for scoping, design, and PS&E phases of project development.

**Table 13. Red Flag Checklist for Unit Cost Adjustment.**

| **Red Flag Questions** | **Selection (Yes/No)** | **Adjustment (+/- %)** | **Work Items Affected** |
|---|---|---|---|
| Is the project located close to location of material source? | | | |
| Is the project located in a congested place or a rural location? | | | |
| Large quantities of materials might decrease the unit price. Are there any such items with large quantities involved? | | | |
| Are there items that are not readily available used in the project? | | | |
| Are there any site constraints involved in this project? | | | |
| Are there any schedule constraints on the contractors involved in this project? | | | |
| Are there any items having fluctuations in their unit prices? | | | |
| Do you anticipate less competition from the contractors for this project? | | | |
| Is there any special construction involved in this project? | | | |
| Is there any lump sum items involved in the project? | | | |

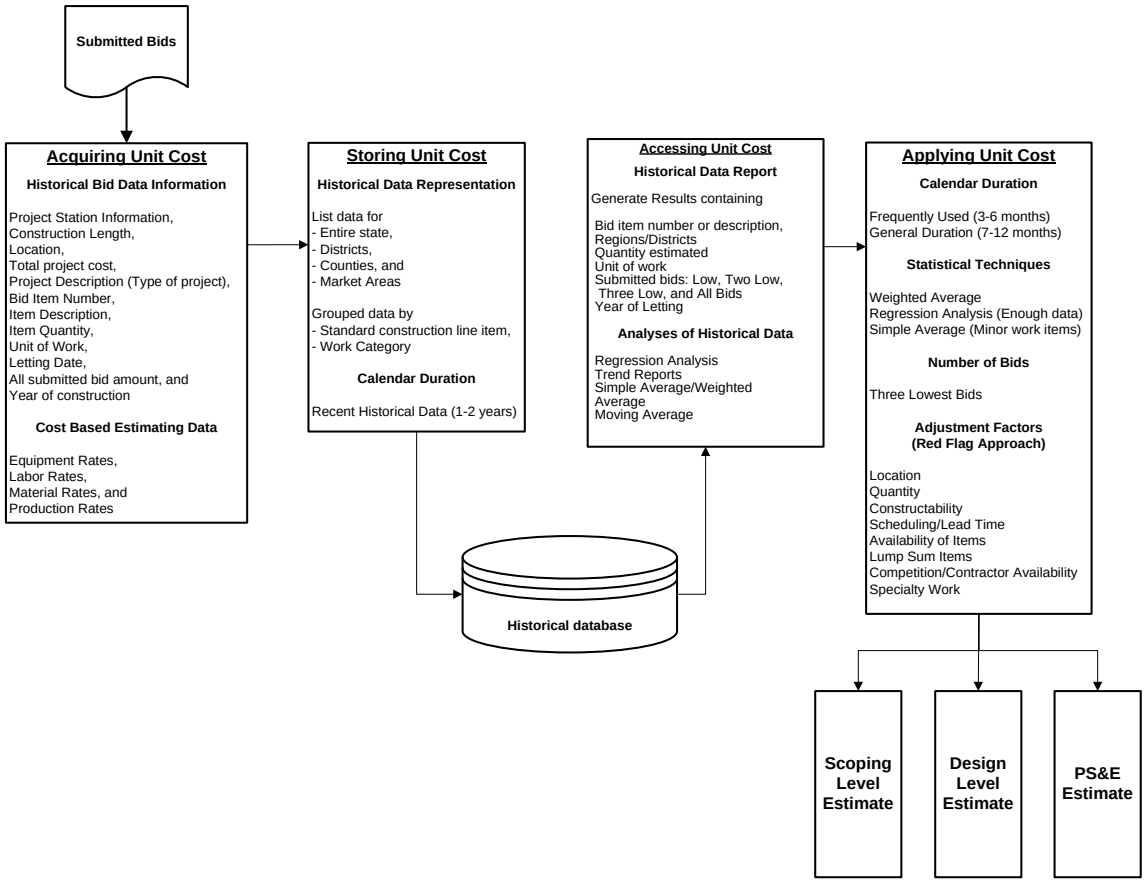


**Figure 75. Unit Cost Development Framework – Scoping/Design/PS&E Phase.**

The use of historical unit costs is dependent upon the type of estimating approach used. In the scoping phase and early design phase, historical bid based estimating is used only to estimate major items of work (80-20 Rule). But as the project progresses from design phase into PS&E phase, cost based estimating in combination with historical bid based estimating is used. It becomes important to use cost based approach when estimating unique projects or projects where the location, market factors, and the volatility of prices as estimating by historical bid based is unreliable. The historical bid

data used in the estimation can no longer be relied upon because they do not represent the actual trend. Cost based estimating, on the other hand, works with the actual cost of different components of work like the equipment rate, material rate, labor and production rate when preparing the estimates. Since this approach uses more recent prices and covers different components of work involved, it is preferable to use cost based estimating technique.

## INFORMATION SYSTEMS

Information systems play a crucial role in successful development of unit costs. The most important information system is the historical database that manages large volumes of data and supplies historical data to estimating software to develop unit costs. Hence it is crucial to establish the database before implementing the framework. Existing systems like the BAMS/DSS, which are commercially available or any in-house developed system (PDBS of UDOT), are capable of performing the requirements described in both the framework for acquiring and storing unit cost information.

After establishing the historical database, the estimates at the planning phase are prepared using the cost-per-mile averages generated from the historical data. These averages can then be made available to the estimators through a simple Excel Spreadsheet. The spreadsheet can then be customized like the Planning Cost Estimate Excel of VDOT or the Concept Cost Estimate of UDOT to prepare the planning level estimate.

For preparing estimates in the scoping phase, design phase, and PS&E phase, the framework demands sophisticated systems for accessing historical data and applying them. Software applications like Tracer (commercial application) or LRE of FDOT (in-house developed) interact directly with the historical database to develop the scoping level estimate. These applications enable parametric estimating to be carried out in the scoping phase. As the project moves into design phase and PS&E phase, the amount of information required by the framework increases substantially. Estimators require powerful reporting software like Bid Tabs Pro or Crystal Reports software to generate the historical bid data report and perform analysis outlined in the framework. Crystal Reports software helps generate customizable average (simple/weighted/moving) price report, while Bid Tabs pro allows estimators to perform regression analysis and generate trend report in addition to listing the average unit price for particular item of work. Finally for developing the design level estimate and the Engineer's Estimate, software applications like Estimator and CES of Trns*port Suite of Software allow estimators perform both historical bid based estimating and cost based estimating to develop the estimates at each phase.

The software applications listed in the above discussion satisfy most of the framework's requirements with exception of red flag checklist. Existing system does not have an automated process to implement the red flag checklist. Only UDOT has the system that implements a similar approach (red flag analysis) to adjust estimates for project factors. But this implementation is at the project level and not at an individual item level as needed by this framework.

## SUMMARY

The framework is based on the results obtained from the survey and the interviews. The use of historical bid data is completely dictated by the estimating technique used and also influenced by the level of information available at the time of estimating. The framework outlines the procedure for utilizing the historical data to perform estimation at different phases of project development. The information systems listed would satisfy most of the requirements of the both the frameworks. Existing applications need to be modified to accommodate the red flag checklist in unit cost development process.

# CHAPTER VII

# CONCLUSIONS

In this chapter, the summary of conclusions along with general recommendations and recommendations for future work is presented.

## CONCLUSIONS

Literature reviews available on unit cost development were limited and were inconclusive in defining a systematic approach to utilizing historical data. Hence the replies from the survey and the interviews were used as basis for developing the framework proposed in this study. The results showed that state highway agencies have different approaches for developing unit costs at various project phases. Many agencies lack a systematic procedure to prepare their planning and scoping estimates. Only some agencies have sophisticated system that helps their estimators prepare the estimates at these two phases. As the project moves into its later phases of development, agencies start to use powerful computer applications to build their estimates. This includes systems which allow estimators to perform detailed analysis of the historical data and generate customizable reports. Though some state agencies have a systematic process in place for preparing project estimates, they have no written documentation on the entire process, including documentation for developing unit costs. SHAs that were interviewed did not have a formal process or method to adjust unit prices for project characteristics

(e.g., complexity, location, size), current market conditions (e.g., bidding environment), or current day prices (e.g., inflation). Adjustments to unit costs were based mainly on experience and engineering judgment of the estimators in all the state agencies. Some state agencies did have a list of factors to consider but did not have a methodology for applying these factors to adjust unit costs.

The research here has tried to capture the best practices and approaches to unit cost development and used this information to formulate a framework. The information obtained from the survey showed that agencies adopt different estimating techniques to prepare estimates at the each phases of project. As a result the historical bid data used in the development of estimates differ based on estimating technique used. Historical bid based estimating was the common estimating technique used in preparing the scoping level estimate, design estimate, and the final Engineer's Estimate, while cost-per-mile approach was used in preparing the planning level estimate. Hence a separate framework for planning phase and another framework common for the other three phases had to be defined. This provided a standardized way to utilize historical data for preparing estimates at these four phases. Further the best practices identified for acquiring unit cost information, storing unit cost information, accessing unit cost information, and applying unit cost information defined a systematic approach to using historical bid data for preparing project estimates. The existing information systems are capable of supporting the two frameworks, though additional work would be required to implement the red flag checklist. The estimation software needs to be modified to permit the use of the checklist in the existing system. The overall purpose of this research was to define a

standardized and a systematic way to utilize historical bid data for construction project estimation. The two framework provided in this thesis would assist in establishing the historical database for estimating highway projects at each phases of project development process. In addition, the information systems outlined in this thesis would provide the necessary tool to implement the two frameworks.

## RECOMMENDATIONS FOR FUTURE RESEARCH

This research has been concluded with the development of a framework that supports a systematic approach to unit cost development. Since the framework is based upon the existing practices in unit cost development, further validation of best approaches to unit cost development need to be performed. Further, additional work could concentrate on obtaining expert opinion from industry personnel on the framework. Future research could focus on developing the red flag checklist to include new factors and to define values for adjusting the unit costs based on the factors selected. Studies could also be conducted to automate the red flag checklist to be integrated into the existing estimation software. Future work could also involve building a similar framework for estimating for maintenance projects

# REFERENCES

American Association of State Highway Officials (AASHTO). (2007). "A Practical Guide to Estimating," *Design Task Force Technical Committee on Cost Estimating,* Washington DC.

California Department of Transportation (Caltrans). (2008a). Division of Engineering Services. < http://www.dot.ca.gov/hq/esc/estimates/forms> (July 1, 2008).

California Department of Transportation (Caltrans). (2008b). Contract Cost Database. < http://sv08data.dot.ca.gov/contractcost/> (July 1, 2008).

California Department of Transportation (Caltrans). (2008c). Contract Item Cost Database. < http://www.dot.ca.gov/hq/esc/oe/costinfo.html> (July 1, 2008).

De La Garza, J., and Oralkan, G. (1991). "Implicit Design Knowledge and Its Impact on Cost Estimating," *Construction Congress Proceedings: Preparing for Construction in the 21st Century*, American Society of Civil Engineers, New York, 412-418.

Florida Department of Transportation (FDOT). (2008a). Generic Cost Per Miles Model. <http://www.dot.state.fl.us/estimates/LaneMileCosts/LaneMilecosts.htm> (June 18, 2008).

Florida Department of Transportation (FDOT). (2008b). Annual Averages (Statewide and Market Areas). <ftp://ftp.dot.state.fl.us/LTS/CO/Estimates/ > (June 18, 2008).

Minnesota Department of Transportation (MnDOT). (2008). Construction Project Abstracts. < http://www.dot.state.mn.us/bidlet/abstract.html > (June 25, 2008).

National Highway Cooperative Research Program (NCHRP). (2007). "Procedures for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction," *NCHRP Report 574*, Transportation Research Board, Washington DC.

New York State Department of Transportation (NYSDOT). (2008a). Weighted Average Item Price Report. <https://www.nysdot.gov/divisions/engineering/design/dqab/waipr> (June 17, 2008).

New York State Department of Transportation (NYSDOT). (2008b). Office of Structures (Engineering Section). <https://www.nysdot.gov/portal/page/portal/divisions/engineering/structures/manuals/preliminary-cost > (June 17, 2008).

Ohio Department of Transportation (ODOT). (2008). Construction Management System. <http://www.odotonline.org/cmsportal> (March 10, 2008).

Pennsylvania Department of Transportation (Penn DOT). (2007). Guidelines on Cost Estimating (Draft). <http://www.dot.state.pa.us/Internet/web.nsf/PennDOTHomepage?OpenFrameSet > (July 12, 2008).

Schexnayder, C. J., Weber, S. L., and Fiori, C. (2003). "Project Cost Estimating a Synthesis of Highway Practice," *NCHRP Project 20-07/Task 152 Report*, Transportation Research Board, National Research Council. Washington, DC.

Texas Department of Transportation (TxDOT). (2007). PS&E Preparation Manual. <ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/pse.pdf> (July 12, 2008).

Texas Department of Transportation (TxDOT). (2008a). Average Low Bid Unit Price. < http://www.txdot.gov/business/avgd.htm > (July 12, 2008).

Texas Department of Transportation (TxDOT). (2008b). Construction Division (Contract Letting). < http://www.dot.state.tx.us/business/bt.htm > (July 12, 2008).

Utah Department of Transportation (UDOT). (2008a). Statewide Estimate Review Process. <http://www.udot.utah.gov/main/uconowner.gf?n=35214810363450832> (June 5, 2008).

Utah Department of Transportation (UDOT). (2008b). Roadway Design Manual of Instruction-Estimating Chapter. <http://www.udot.utah.gov/main/uconowner.gf?n=519455313302721722> (June 5, 2008).

Utah Department of Transportation (UDOT). (2008c). Concept Cost Estimate Form. < http://www.udot.utah.gov/index.php/m=c/tid=721 > (June 5, 2008).

Utah Department of Transportation (UDOT). (2008d). Statewide Average Unit Low Bid Prices. <http://www.udot.utah.gov/main/f?p=100:pg:12302720542229821131:::1:T,V:446> (June 5, 2008).

Utah Department of Transportation (UDOT). (2008e). Red Flag Analysis Help Manual. < http://udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1624,> (June 5, 2008).

Virginia Department of Transportation (VDOT). (2008a). Guidelines and Procedures for Estimating and SAAP Section-Scheduling & Contract Division.

<http://www.virginiadot.org/business/const/internalprocesses.asp> (October 15, 2008).

Virginia Department of Transportation (VDOT). (2008b). Planning Cost Estimate System. <http://virginiadot.org/> (March 10, 2008).

Virginia Department of Transportation (VDOT). (2008c). Historical Bid Price Listing. < http://www.virginiadot.org/business/const/ > (October 15, 2008).

Washington State Department of Transportation (WSDOT). (2008a). Cost Estimating Guidance for WSDOT Projects. <http://www.WSDOT.wa.gov/Projects/ProjectMgmt/RiskAssessment/> (August 19, 2008).

Washington State Department of Transportation (WSDOT). (2008b). Unit Bid Analysis System. <http://www.WSDOT.wa.gov/Design/ProjectDev/EngineeringApplications/UnitBidHistory.htm> (August 19, 2008).

Washington State Department of Transportation (WSDOT). (2008c). Bid Tabs Pro Manual. <http://www.wsdot.wa.gov/Design/ProjectDev/EngineeringApplications/BidTabs.htm> (August 19, 2008).

Williams, R., Hildreth, J., and Vorster, M. (2007). "A Bid Item Level Performance Time Database Management System as Part of a Framework for Progressively Estimating Contract Time," *Transportation Research Board 86th Annual Meeting*, Washington DC.

# APPENDIX A

## TxDOT SURVEY RESULTS

| Sl No | DOT | Estimation Process | Formal Process/Systematic Tool(Y/N) | Estimation System Used | Web Location | Point of Contact | Other Information |
|---|---|---|---|---|---|---|---|
| 1 | Tennessee | Tennesse does not have a system that will develop prices based on the complexity. Tennessee makes use of their "In House" system to break down prices received from various bidders based on the quantity, time period, county,region. | N | Using In house program for breaking down bid items | NA | Daid Donoho, Director of construction, TDOT | |
| 2 | West Virginia | Maintains "Average Unit Bid" list on a yearly basis | N | NA | NA | NA | |
| 3 | Kentucky | No formal process to categorise the unit prices based on complexity, difficulty or type of projects when developing the final engineers estimate | N | NA | NA | Ryan Griffith, Transportation Engineer Branch Manager | |
| 4 | New Hampshire | No Formal process to determine the unit prices for the contract | N | NA | NA | Theodore Kitsis,P.E., Administrator Bureau of Construction | |
| 5 | Virginia | VDOT has staff of estimators preparing the VDOT's Bid for the project. The process include "rational cost estimate" for 65% value of the contract. The balance (35%) is generally determined by the Trns.port statistically. This is used in the early design life of the project, however on most project, for advertisements the estimate is based on bid histories. The estimation process is given in the Estimation Guideline Procedure manual of VDOT | Y | Trns.port | http://www.virginiadot.org/business/const/default.asp | Tom Thompson, State Estimates and Bids Engineer,VDOT | |
| 6 | Iowa | The estimation process doesn't consider the project complexity or the difficulty when preparing the estimate. These are generally done using the Trns.port software. For negotiating contract modifications, summary of the awarded prices is used to compare with the requested prices. | N | Trns.port | NA | Roger Bierbaum, Contracts Engineer | |
| 7 | Alaska | The Alaska DOT doesn't have a formal, systematic tool for estimating unit prices. The estimates are generally prepared based on the past bids with adjustments for uniqueness of work. | N | NA | NA | Pat Carrolll, Design Group Chief | |
| 8 | Missouri | The estimation process involves using the historical unit bid prices for each district. The justification is looked at with the quantities involved and difficulty in performing the work. | N | NA | NA | Randy Hitt, Asst State Construction and Materials Engineer. | |

| Sl No | DOT | Estimation Process | Formal Process/Systematic Tool(Y/N) | Estimation System Used | Web Location | Point of Contact | Other Information |
|---|---|---|---|---|---|---|---|
| 9 | Vermont | Vermont uses the Trns.port suite of softwares (Estimation SW like the CES, Estimator) for estimating. The project complexity, difficulty or type of project are manually adjusted based on the project managers consideration. | N | Trns.port | NA | Mike Fowler | |
| 10 | Illinois | IDOT uses the ProEstimating Heavy (Oman Systems) for estimation of construction process. This is supplemented by the Oman's Bid Tabs Professional for historical cost associated with non-major items. The impact on the production rates, equipements needed for the major line items like the earth work, paving and structure due to the complexity and size of the project is determined based on the knowledge and experience of the estimator | Y | ProEstimating Heavy, Bid Tabs Professional | NA | | http://www.hcss.com, http://www.bid2win.com, http://www.harddollar.co Http://www.infotechfl.cor olutions/estimator.php |
| 11 | Colorado | The estimation process was changed from Historical bid based platform to combined cost based/historical approach. In cost based estimation, the costs are determined reviewing the material, labor and equipments seperately. The estimators use the Davis Bacon for labor rates and Blue book for equipments rate.Also a 10% to 20% profit or overhead factor is considered depending on the work type, number of plan holders etc. Historical based estimation or basic estimation procedure involves estimating a project using the historical bid information for all items of work, determining the major line items that comprise a minimum of 20% value of biddable item total, re-evaluating unit prices of major line items using a cost based approach. | Y | NA | NA | Gus Bieber, Engineering Estimates Program Manager | |
| 12 | Florida | FDOT doesn't have a formal process to account for project complexities and difficulty. FDOT uses the Trns.port CES for estimation. Separate cost libraries are maintained in CES for projects with time duration less than 2 years and 2 years or greater. | Y | Trns.port CES | NA | Cherri Sylvester | |
| 13 | New Jersey | NJDOT uses the Trns.port CES system for estimation purpose. | Y | Trns.port CES | http://www.state.nj.us/transportation/business/trnsport/estimation.shtm | Joe Weber, Project Manager TRNS.port | AASHTO Tracer produc |
| 14 | Indiana | No system with that detail present for them | N | NA | NA | NA | |
| 15 | Georgia | No system that handles the project complexities, difficulties in the estimation process. The Weighted average for all pay items based on quantities are used by the estimating section to come out with the estimates for each letting. | N | NA | NA | Gregory T Mayo,P.E. Director of Construction GADOT | |
| 16 | Rhode Island | RIDOT uses the weighted average unit prices for estimates. But it doesn't consider the project complexities, type of work and difficulty. | N | NA | NA | Christos Xenophontos, Administrator, Contract Administration Section | |
| 17 | Wyoming | No formal process | N | NA | NA | NA | |
| 18 | North Dakota | No formal process using a systematic tool at this time | N | NA | NA | NA | |

| Sl No | DOT | Estimation Process | Formal Process/Systematic Tool(Y/N) | Estimation System Used | Web Location | Point of Contact | Other Information |
|---|---|---|---|---|---|---|---|
| 19 | Nevada | No formal process at this time | N | NA | NA | Gary Selmi, Chief Construction Engineer | |
| 20 | Oregon | Oregon DOT uses the Trns.port estimating system to make the regional, work type and quantity cost adjustments. For the labor, material and equipment rates, manual cost development in done. Oregon is currently reviewing the use of TRACER for estimation purpose | Y | Trns.Port Estimation System, Tracer | NA | John Riedl, PE, Senior Cost Engineer | AASHTO's Estimation T Development of Combine History and Cost Estimati |
| 21 | Lousiana | Lousiana DOT does not have a system that categorises the items based on the project type. Weighted average unit cost cost is used for the estimation purpose. | N | NA | http://www.dotd.la.gov | | http://www.dotd.louisiana bin/construction.asp |
| 22 | Caltrans | Caltrans doesn't have a systematic tool for developing unit prices | N | NA | NA | Ray Titt | |
| 23 | Washington | WsDOT uses the historical bid costs in developing Engineer's estimate. However the system doesn't consider the project type and complexity. | Y | NA | NA | David Mariman, WSDOT States Specification Engineer | |
| 24 | Maryland State Highway administration | Price Index History is used as the basis for the estimation | N | NA | NA | Mark Flack | |
| 25 | Ohio | ODOT utilizes the unit bid prices for estimation purpose. The office of estimation has a separate web site for the estimation process. The Ohio DOT keeps historical bid data in a database searchable by the rest of the department when estimating for a new work. | Y | NA | http://www.dot.state.oh.us/contract/estimating/itemsearch.asp | Bob Jessberger, ODOT, Construction Specialist | The database helps searc numbers of description w bid data from the past yea similar work with a simila |
| 26 | Mississippi | Mississippi DOT doesn't have a systematic tool that does estimation based on the complexity and the difficulties | N | NA | NA | NA | |
| 27 | District DOT | No system at this time | N | NA | NA | NA | |
| 28 | Maine | Maine DOT doesn't have a systematic tool. Past prices on similar projects are used | N | NA | NA | Scott Bickford, Contracts & Specifications Engineer | |

| Sl No | DOT | Estimation Process | Formal Process/Systematic Tool(Y/N) | Estimation System Used | Web Location | Point of Contact | Other Information |
|---|---|---|---|---|---|---|---|
| 29 | Kansas | Kansas DOT doesn't have a formal process. Average Bid tab is used and estimation is done manually taking into consideration the project, area and quantity. | N | NA | | Susan Darling,Asst Bureau Chief, Construction & Maintenance | |
| 30 | Utah | Utah uses PDBS Estimates Module which allows the user to pull all average bid prices or prices based on Date Range, quantities or location. | Y | PDBS | NA | Thomas LeHolm,Manager, Contracts, Est & Agreements | The PDBS is likely to be Intranet, as it is available t of the PDBS system. |
| 31 | Oklahoma | Oklahoma DOT uses the Trns.port modules for estimation purpose. The Trns.port doesn't provide the bid prices based on the type of project or the complexity | Y | Trns.port | NA | Brad Hartronft (bhartronft@odot.gov) | |
| 32 | Arkansas | AHTD relies on engineering judgement for an appropriate unit price when the factors like the project type, complexity and difficulty are giving suitable weights when making the decision | N | NA | NA | Charles Clements, Engineer of Roadway Design | |
| 33 | Minnesota | MnDOT uses the Cost Estimation System (CES) of the Trns.port for preparing the Engineer's Estimate. Supplemental Agreements or work orders are prepared using the historical averages and cost based methods as well but without using CES | Y | Trns.port | NA | Nancy Sannes,Estimating Unit | |
| 34 | Alabama | Alabama DOT doesn't have a formal tool for use when evaluating quotes/prices for added work post-letting. Bid history is used for the purpose of estimation. | N | NA | NA | - | |
| 35 | Montana | Montana DOT is in the process of hiring a Cost Estimator that will establish unit price data using the actual cost data. Currently Decision Support System (DSS) and Estimator of the Trns.port suite of softwares are used to create catalogs for prices to be generated. The bid history prices are adjusted for quantity, region, complexity and type of project. | Y | Trns.port | NA | Suzy Price | |
| 36 | Massachusetts | Massachusetts relies on the construction bid cost data. MaDOT uses an application to eliminate the high/low values and uses the remaining costs for a weighted unit price average. | Y | NA | http://www.mhd.state.ma.us/PE/WeightedAverageCriteria.aspx | Carol Hebb, P.E Construction Engineer | |
| 37 | New York | NysDOT uses the Trns.port suite of Softwares for Estimation. | Y | Trns.port | https://www.nysdot.gov/portal/page/portal/main/business-center/trns-port/modules | David L. Kent, P.E., Design Quality Assurance Bureau | The web address gives a modules that they use in t application for developing estimate |

# APPENDIX B

## ONLINE SURVEY QUESTIONNAIRE

Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI)
Synthesis on Construction Unit Cost Development

## Request for Participation

## Background

The Texas Transportation Institute (TTI) is undertaking a research project to develop a ***Synthesis on Construction Unit Cost Development*** for the Texas Department of Transportation (TxDOT). The synthesis focuses on how other State Highway Agencies (SHAs) develop unit prices for construction and maintenance project estimating. It will explore current practices in determining the unit costs based on historical bids and/or historical production rates, crew sizes and material costs. Information on the processes and procedures followed by other SHAs will form the basis from which recommended best practices and a procedure to implement these practices will be provided to TxDOT. An additional focus of this synthesis is describing for cost estimating purposes a methodology whereby historical data is adjusted based on project conditions.

### Historical Data

Four generic phases are used in this research to characterize the project development process. These phases are shown below with a brief description of the plan or program they support:

- Planning – concept definition to support a 20 year long range plan
- Scoping – basic scope definition to place a project into a priority program (10 years or less from the project letting date)
- Design – development of plans and specifications to support a project in the State Transportation Improvement Program (4 years or less from the letting date)
- PS&E – final plans and specifications to support an Engineers' Estimate for letting a project for construction

Cost estimation occurs repeatedly throughout the four project phases. The types of estimating techniques used vary depending on the project phase and level of project scope information available. Historical cost data that supports the preparation of estimation also varies based on the estimating techniques. Historical bid prices are often used when preparing cost estimates. At the PS&E phase, bid pricing is the most common approach, although some SHAs use production rates, crew sizes, labor wage rates, material costs and equipment cost to build up a unit price for their Engineers' Estimates. Historical bid prices are more frequently used for estimates prepared in the scoping and design phases. In the planning phase, historical unit prices are often used to develop average lane mile costs for planning estimates. Thus, the use of historical bid pricing and other related approaches to how historical data is developed for cost estimation across the project development process is of interest to TxDOT.

## Survey Structure

The research team has formulated a questionnaire to identify good practices specifically with respect to unit cost development. The survey questionnaire is divided into the following sections: ***Section I-Construction Unit Cost,*** addressing the unit cost information for construction projects and ***Section II-Maintenance Unit Cost,*** addressing the unit cost information for maintenance projects. The ***Section I-Construction Unit Cost*** is divided into five sections. The first is a ***General*** section***,*** which focuses on identifying whether your state agency has a structured construction unit cost database and unit cost development procedure in place. The second section is ***Acquiring Unit Cost Information,*** which identifies the use of any system that extracts unit cost information from the past contract details and stores them in an historic cost database. ***Storing Unit Cost Information*** is the third section focusing on how the unit cost details are stored in the database. The last two sections are ***Accessing Unit Cost Information,***

which identifies the presence of any mechanism to access historic unit cost information and ***Applying Unit Cost Information,*** which focuses on the use of the unit cost information in the estimation process.

Key Definitions are:

- **Unit Cost Database**

  Unit Cost Database is a repository of the cost associated with all standard items of work taken from the previously awarded contracts or bids and stored in a suitable format which will aid the estimator when preparing cost estimates for highway projects.

- **Historical Bid-Based Estimating**

  Historical Bid-Based Estimating is a method used in developing estimates using the data from the **unit cost database**. The unit prices from this database may be adjusted to reflect the specific project/location (geographic) conditions.

- **Cost-Based Estimating**

  Cost-Based Estimation is a method used in developing project estimates using a production rate and the cost associated with labor, materials, and construction equipment. By estimating the cost of each component required to complete the work together with a Contractor's profit and overhead an estimated unit price for the work can be developed. This method also takes into account the unique character of the projects, geographical influences, market factors and the volatility of material prices.

**Respondent's Information**

Agency :

Name :

Title :

Email :

Telephone Number :

Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI)
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## SECTION I

### Construction Unit Cost

### General

1. Is Historical Bid-Based Estimating your agency's **primary** estimating technique?
   a. Yes
   b. No

**If 'Yes' for Question 1, please answer Question 2.**

2. If Historical Bid-Based Estimating is used, in which project phases is it **most often** applied? [Select all that apply]

- Planning - concept definition to support a 20 year long range plan
- Scoping – basic scope definition to place a project into a priority program
- Design – development of plans and specifications to support a project in the State Transportation Improvement Program
- PS&E – final plans and specifications to support an Engineers' Estimate for letting a project for construction

3. Is Cost Based Estimating your agency's **primary** estimating technique?
   a. Yes
   b. No

**If 'Yes' for Question 3, please answer Question 4 and Question 5.**

4. If Cost Based Estimating is used, in which project phases is it **most often** applied? [Select all that apply]

- Planning - concept definition to support a 20 year long range plan
- Scoping – basic scope definition to place a project into a priority program
- Design – development of plans and specifications to support a project in the State Transportation Improvement Program
- PS&E – final plans and specifications to support an Engineers' Estimate for letting a project for construction

5. If Cost Based Estimating is used, does your agency periodically track the following? [Select all that apply]

- Actual production rates and crew sizes
- Current material unit costs
- Actual construction equipment production rates

6. Does your agency use a computer based system for preparing estimates during different phases of the project development?
   a. Yes
   b. No

If '**Yes**', please provide the name of system used in different phases of project development given below. Also specify whether the system is commercially available or an in-house developed program.

(e.g., Trns*port Cost Estimating System – Commercial and/or Excel Spreadsheet – In-House)

**Planning:**

**Scoping:**

**Design:**

**PS&E:**

7. Does your agency have a well documented process or procedure for developing unit costs for construction cost estimating (process/procedure covers acquiring, storing, accessing and applying unit costs)?
   a. Yes
   b. No

   If '**Yes**', please provide the web address if it is accessible over Internet or a copy of the document?

8. Is your agency using any innovative techniques for developing unit costs for construction cost estimating (e.g., maintaining libraries of historical unit costs based on market areas)?
   a. Yes
   b. No

**Acquiring Unit Cost Information - Construction**

9. How is cost data for the unit cost database acquired from bid details?

   a. Commercial Software (e.g., BAMS/DSS)
   b. In-House Software
   c. Both
   d. Other, specify

10. Which types of historical bid data are acquired from bid details in your agency?

- Low bid only
- Low and second bid
- Three lowest bid
- All bids excluding single bid that may be higher or lower
- All bids except high and low bid
- All bids

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**Storing Unit Cost Information - Construction**

11. Where is historical unit costs maintained within your agency?
    - Computer software (e.g., BAMS/DSS) – Commercial
    - Computer software – In-House
    - Spreadsheet – In-House
    - Other

    If **Other**, please specify.

12. Over what calendar duration are historical unit costs stored in the database?
    - One Month
    - Twelve Months
    - Three Years
    - Five Years or more

13. Are historical unit costs available based on:
    - Statewide only
    - District/Regions only
    - Market areas
    - Counties
    - Other

    If **Other**, please explain.

14. How does your agency store historical unit cost information (Select all that apply)?
    - Standard construction line items
    - Different work categories (e.g., Grading/Excavation, Asphalt, Bridge, Traffic Control)
    - Project types ( e.g., Bridge replacement, lane widening , intersection reconstruction etc )

**Accessing Unit Cost Information - Construction**

15. Can historical unit costs be accessed over your agency's:
    a. Internet
    b. Intranet
    c. Both
    d. None

    If available over Internet, please provide the web address.
16. Does your agency have a system to sort and summarize historical unit cost data based on different input parameters (e.g. standard line item number, project size, quantity range, time period)?
    a. Yes
    b. No

17. Is the above system developed [select all that apply]
    - Commercially (e.g. Bid Tabs Pro)
    - In-House

18. If Commercially available system, please provide the name of the system
19. If In-House system, can it be accessed over the Internet? If '**Yes**', please provide the web address

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**Applying Unit Cost Information - Construction**

20. Over what calendar duration are historical unit costs averaged to create the unit cost data for estimating? [Select dominant choices]
    - One Month
    - Twelve Months
    - Three Years
    - Five Years or more
21. What statistical techniques are used to determine the unit prices for cost estimating? [Select all that apply]
    - Simple Average
    - Weighted Average
    - Median
    - Mode
    - Scatter plots with best fit
    - Other, specify
22. What items of work are these statistical techniques most often applied to?
    - Major items of work
    - Minor items of work
    - Both
    - Other, specify

23. Does your agency use Moving Averages for determining the historical unit costs?
    a. Yes
    b. No

**If 'Yes', answer the Questions 22 and 23.**

24. What time period is considered for calculating the moving average?

25. What type of moving average is considered?
    a. Weighted Moving Average
    b. Simple Moving Average

26. Does your agency have a formal process/method (documented) to adjust historical unit prices for project size, project location and project complexity when preparing a cost estimate?
    a. Yes
    b. No

27. Does your agency have a formal process/method (documented) for adjusting the unit prices to reflect the current market condition (e.g., bidding environment)?
    a. Yes
    b. No

28. Does your agency have a formal process/method (documented) for adjusting historical unit prices to reflect the current day prices (i.e., impact of inflation)?
    a. Yes
    b. No

**SECTION II**

**Maintenance Unit Cost**

1. Does your agency maintain a database for maintenance unit costs?
    a. Yes
    b. No

2. Does your agency have a well documented process or procedure for developing historical unit costs for maintenance projects (process/procedure covers acquiring, storing, accessing and applying unit costs)?
    a. Yes
    b. No

3. Please describe the differences (if any) in the procedure for acquiring, storing, accessing and applying of maintenance unit cost data from that of construction unit cost given in Section I? (Enter NA if not applicable)

# APPENDIX C

## FOLLOW UP INTERVIEW QUESTIONNAIRE – VDOT

**Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI)**
**Synthesis on Construction Unit Cost Development (Phase II)**

**MEMORANDUM**

**TO**: Richard Kiefer
Virginia Department of Transportation

**FROM**: Stu Anderson
Principal Investigator

**SUBJECT**: Unit Cost Development Phase II Interview

Thank you for participating in the Unit Cost Development Survey concerning methods to derive unit prices for construction and maintenance project estimating. We are interested in discussing in detail your process for developing unit prices and have set up a telephone interview for June 4, 2008 at 2.00 pm EST. We have attached your response to our earlier survey on unit cost development for reference along with the questions we plan to discuss with you during our telephone interview.

If you have any questions, please contact me by telephone at 979-845-2407 or by email at s-anderson5@tamu.edu.

**Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI)**
**Synthesis on Construction Unit Cost Development (Phase II)**

## BACKGROUND

The Texas Transportation Institute (TTI) is undertaking a research project to develop a 'Synthesis on Construction Unit Cost Development' for the Texas Department of Transportation (TxDOT). The synthesis focuses on how other State Highway Agencies (SHAs) develop unit costs for construction and maintenance project estimating. Phase I of the project involved conducting an online survey to identify SHAs conducting considerable work in the development of unit prices for estimation purposes. The survey was divided into two parts. Part I, Construction Unit Cost Information, had five sections addressing different aspects of unit costs, namely:

1. General Section;
2. Acquiring Unit Cost Information;
3. Storing Unit Cost Information;
4. Accessing Unit Cost Information; and
5. Applying Unit Cost Information;

Part II of the survey covered Maintenance Unit Cost Information development.

Phase II of this project focuses on understanding current processes regarding the development of the unit prices in greater detail. Phase II follows the five sections described above for Construction Unit Cost Information. Your response to the Phase I survey for each of the five sections formed the basis for this followed up telephone interview.

### General

1. How does your agency arrive at unit cost information support the following estimating programs:
    - In-House Excel (Planning)
    - Project Cost Estimating System (Scoping)
    - Trns*port PES (Design)
    - Estimator – Rational Estimate (PS&E)

2. What information does your In-House Excel program capture about the project?
3. How does your agency use the In-House Excel program to derive a preliminary estimate?
4. Does your agency make any assumptions for inflation, contingency, preliminary engineering and construction engineering, etc. that are used in the In-House Excel program? If so, how do these assumptions change based on project type, project conditions, complexity and size, etc.?
5. How does the Project Cost Estimation System (PCES), used in your scoping phase, work in preparing the estimate?

6. How is the Trns*port PES software used in your design phase?
7. How is the rational estimate performed?
8. What are the innovative techniques used by your state agency for developing construction unit cost?
    a. How is it helping your agency in the estimation process?

**Acquiring Unit Cost Information**

9. Besides the Blue Book for rental rates, what other sources do you consider for determining the rental rates?
10. How is the information from the In-House Excel program and PCES used by the Trns*port system?

**Applying Unit Cost Information**

11. What criteria(s) does your agency consider when adjusting the RS Means Data for production rates?
    a. How does the criteria change based on:
        - Project phase
        - Project Condition, Project type, complexity, and size, etc.
12. What does the second increment in the labor rate estimation cover? Is it to adjust for inflation or any other factor?
13. What criterion does your agency use to categorize major and minor items of work?
14. How does your agency establish the prices for major and minor items of work?
15. Does your agency compare the historical data available for district and state when determining the unit cost? Do you modify the historical unit cost based on the comparison? If so, how?
16. How does your agency use the 'weighted average' and/or 'scatter plots' in establishing the unit price?
17. What is the rationale behind using historical data available over 12 month's time to determine the unit price instead of using recent historical data?

**Maintenance Unit Cost**

18. What information does your maintenance unit cost database contain and how different is it from construction unit costs database?
19. How does your agency arrive at the unit prices for maintenance projects?

# VITA


| | |
|---|---|
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